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An Integrated Resource and Biological Growth Model for Estimating Algal Biomass Production With Geographic Resolution

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An Integrated Resource and Biological Growth Model for Estimating Algal Biomass Production With Geographic Resolution

by

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Thesis

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Dedication

This thesis is dedicated to my parents, Steve and Yugene Wogan, my sister Lisa Wogan, and our dog Sekanji, for always being supportive of my aspirations and teaching me to never give up.

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I would like to thank my advisors, Dr. Michael E. Webber and Dr. Alexandre K. da Silva for their guidance and support over the past few years in my research and providing unique internship opportunities. I also wish to acknowledge the support of The Energy Foundation, Dr. Halil Berberoglu, and Veronica Pulido for their help with my thesis. I would like to thank my friends and roommates, particularly Andy Yin and Reid Long, for their encouragement, support, and unwavering friendship. Finally, I would like to thank my family (Steve, Yugene, Lisa, and Sekanji Wogan) for always being there for me and constantly being a positive influence in my life.

Abstract

An Integrated Resource and Biological Growth Model for Estimating Algal Biomass Production With Geographic Resolution

by

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The University of Texas at Austin, 2010

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This thesis describes a geographically- and temporally-resolved, integrated biological and engineering model that estimates algal biomass and lipid production under resource-limited conditions with hourly and county resolution. Four primary resources are considered in this model: sunlight, carbon dioxide, water, and land. The variation in quantity and distribution of these resources affects algae growth, and is integrated into the analysis using a Monod model of algae growth, solar insolation data, and published values for water, carbon dioxide, and land availability. Finally, lipid production is calculated by assuming oil content based on dry weight of the biomass. The model accommodates a range of growth and production scenarios, including water recycling, co-location with wastewater treatment plants and coal-fired generators, and photobioreactor type (open pond or tubular), among others. Results for every county in Texas indicate that between 86 million and 2.2 billion gallons of lipids per year can be produced statewide for the various growth scenarios. The analysis suggests that algal biomass and lipid production does indeed vary geographically and temporally across

Texas. Overall, most counties are water-limited for algae production, not sunlight or carbon dioxide-limited. However, there are many nuances in biomass and lipid production by county. Counties in west Texas are typically not solar- or land-limited, but are constrained by either water or carbon dioxide resources. Consequently, counties in east Texas are limited by either water, or land (depending on the fraction of water recycling). Varying carbon dioxide concentration results in higher growth rates, but not always increased biomass and lipid production because of limitations of other resources in each county.

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Chapter 1: Introduction and Background

1.1. POLICY CONTEXT AND RATIONALE

Biofuels have been proposed to alleviate environmental, security, and sustainability concerns associated with the production and consumption of conventional transportation fuels. [1, 2] To date, biofuels are primarily produced in the United States from crop-based feedstocks such as corn and soybean. Algae have been suggested as a potential alternative feedstock for the production of biologically-derived fuels including biodiesel, synthetic gasoline and diesel, jet fuel, and hydrogen because it is not based on a crop used for food. [3-5] Algae-based biofuels are appealing because they have fast growth rates; consume carbon dioxide during photosynthesis; grow in many regions and conditions (including on non-arable land); and in some cases do not compete with freshwater sources for growth. [6-8] Compared to terrestrial crops, algae potentially utilize solar energy more efficiently because they are not limited to one growth cycle per year and can be harvested much more often.

In 2007, the U.S. Congress passed the Energy Independence and Security Act (EISA 2007), which includes provisions for producing up to 36 billion gallons per year of renewable transportation fuels by 2020; of which 5 billion gallons a year can potentially be produced from algae. In addition, possible carbon legislation in the form of either a carbon tax or cap-and-trade system is generating interest in low-carbon fuels, including algae. Despite these benefits and incentives, algae-based biofuels have yet to be produced economically on a large scale or at prices competitive with conventional fuels. The Department of Energy's National Renewable Energy Laboratory (NREL) led an extensive study of growing and producing algae for use as a biofuel feedstock with its aquatic species program. [3] After nearly two decades of research, NREL concluded that reliably controlling and optimizing algae growth processes is difficult. A recent study concludes that these challenges remain, but progress is being made. [9] However, a robust assessment of algal biomass production incorporating geographic and temporal resource limitations has not been performed.

1.2. PREVIOUS RESEARCH AND LITERATURE REVIEW

Biological growth modeling has been well-known for decades and multi-layer geographic analysis has been a useful tool for spatial-resolved analysis of resources. Traditional algae growth modeling focuses on the details and intricacies of the biological processes that govern biomass production, but typically lack information about the availability, temporal variability, or distribution of resources. [10-16] Years of research have been performed to identify and understand the biological growth processes that govern algae production, Consequently the general behavior of algae growth at the cellular level is understood. [17]

However, meaningful estimates of algae production are not known because resource constraints are not typically included in these estimates. Likewise, resource assessments and estimates of algal biomass production that have been conducted lack the fidelity of dynamic growth models. [9, 18, 19] This analysis fills the knowledge gap by integrating with geographic and temporal resource limitations with a dynamic growth model. Therefore, limitations and nuances in biomass production can be understood for a range of growth conditions and resource limitations.

1.3. ALGAE PRODUCTION METHODS

Algae are often found growing in ponds, waterways, or other locations that have the right combination of meteorological conditions, sunlight, water, nutrients, and carbon dioxide. Growth depends on many factors and can be optimized for temperature, sunlight utilization, pH control, and fluid mechanics. [20-23] Manmade production of algae typically seeks to mimic the natural environments to achieve optimal growth conditions, while allowing for large-scale production, harvesting, and process control. Anthropogenic algae production systems can be organized into two distinct categories: open ponds and closed photobioreactors. Open ponds are relatively simple expanses of water recessed into the ground with some mechanism to deliver carbon dioxide and nutrients with paddle wheels to circulate the algae broth. Closed photobioreactors are a broad category referring to systems that are enclosed and allowing more precise control over growth conditions and resource management. Table 1 presents a brief comparison of open pond systems and closed photobioreactors. Each system has benefits and drawbacks with respect to optimal growth conditions. Brief overviews and discussions of both systems comprise the next two subsections.

Table 1. Advantages and disadvantages of open and closed algae growth systems. [24, 25]

Parameter	Open Pond	Closed Photobioreactor
Construction	simple	complicated - varies by design
Cost	inexpensive	expensive construction, operation
Typical Growth Rates (g/m2-day)	low: 10-25	variable: 1-500
Water losses	high	Low
Typical biomass concentration	low: 0.1-0.2 g/L	high: 2-8 g/L
Temperature Control	difficult	easily controlled
Species Control	difficult	Simple
Contamination	high risk	low risk
Light utilization	poor	very high
CO_2 losses to atmosphere	high	almost none
Area requirements	large	Small
Depth/diameter of water	0.3 m	0.1 m
Surface:volume ratio (m^2/m^3)	~6	60-400

1.3.1. Open Pond Reactors

Open pond reactors are relatively simple growth systems. Pond reactors are unsophisticated and consist of little more than a recess in the ground, sometimes lined with plastic, fashioned into a raceway pattern. Algae and nutrients are fed into the beginning of the raceway while paddlewheels help stir the broth and provide flow around the pond. A typical open pond reactor is shown in Figure 1 below.

Figure 1. Raceway pond from Seambiotic in Israel. [20]

Actual open ponds range in size of up to 1 hectare (1 hectare = 10,000 m^2) and volumes ranging from 100 liters to over 10 billion liters. [21, 22] Open ponds are the most common production facilities due to their simplicity, lower cost of construction and operation, which is very well understood. Open ponds are used almost extensively in growing algae for nutritional supplements (e.g., Spirulina) and have been used for many years. Unfortunately open ponds are not without drawbacks. The simplicity of the systems leads to problems with controlling the growth environment and operating conditions delivering less than ideal algae yields. While ponds typically produce more algal biomass per acre of land than terrestrial crops, a significant amount of land must be used to grow algae in ponds.

Most ponds are open to the atmosphere, which allows unwanted or competing strains of algae with undesirable properties to enter the pond. These competing algae strains can potentially take over the pond rendering the harvest useless. Contamination by unwanted strains can be avoided by covering the ponds with a greenhouse or tarp, and even using pesticides to eliminate certain species of algae. These mitigation steps represent significant cost and embedded energy. Carbon dioxide is usually delivered to the ponds through natural mass transfer from the atmosphere to the water. Carbon dioxide can be bubbled through the water to increase the amount of dissolved gas, but unused carbon dioxide still escapes into the atmosphere. Other growth conditions such as temperature and pH are difficult to control as well. Temperature is difficult to maintain because of heat transfer to the environment, which changes with the season and time of day, and nutrient and oxygen production affect the pH of the water. These growth conditions can be controlled, which adds complexity to the production system. Growth rates are generally lower for open ponds compared with tubular photobioreactors because sunlight energy is diminished below the water surface leaving algae cells at the bottom of the pond with little energy for growth. Mixing can be implemented to allow algae cells adequate exposure to photons, but mixing is not a complete solution.

1.3.2. Closed Photobioreactors

While pond reactors are open to the atmosphere, closed photobioreactors are enclosed systems in the form of tubes or plates that contain the algae broth. Closed photobioreactors are more complicated than open pond systems, but allow for much finer control over growth conditions and inputs in a more compact area. [25, 29] A tubular photobioreactor (shown in Figure 2) is one of the more common closed designs. Other designs include flat plate reactors, inclined plates, helical coils, and combinations of different designs. Closed reactors are generally more expensive to construct and operate due to materials, pumps and control equipment required, but overall algae growth is higher compared to open systems because of greater control over the growth conditions and inputs.

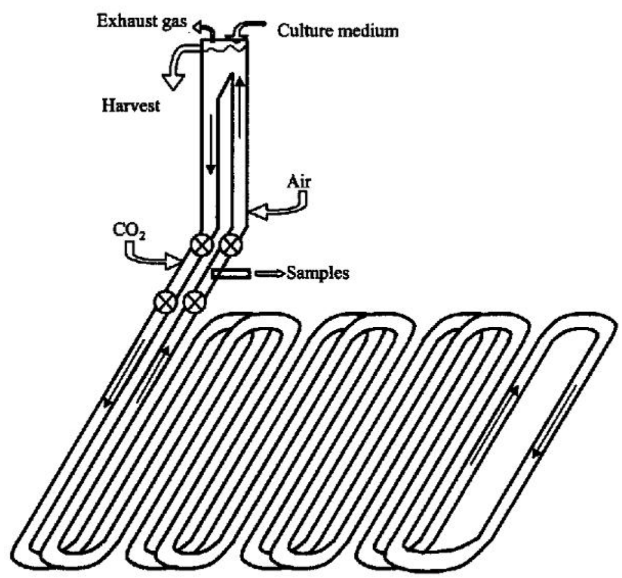

Figure 2. Schematic of a typical closed photobioreactor. [23]

Closed tubular or plate type photobioreactors tend to have smaller dimensions compared with open pond systems. Tube diameters are typically less than 0.1 meters and can be up to 80 meters in length. [21] Some of the problems with growth in ponds are resolved when using a closed reactor. For example, complete control over temperature, pH, nutrient inputs, and mixing is achievable using a closed system. This control allows growth conditions to be optimized and repeated consistently for maximum or desired yield. Unwanted algae strains are of less concern because the system is isolated from the outside environment. Higher concentrations of carbon dioxide can be delivered to the algae with less escaping to the atmosphere while unused carbon dioxide can be recaptured and reused. Because the depth of algae broth is reduced from 0.3 meters to less than 0.1 meters, fewer photons are attenuated in the broth allowing more algae cells to receive sunlight energy. [24, 30] Closed photobioreactors are usually not operated on large scales (many hectares) due to prohibitive costs and difficult operation and maintenance. In order for closed photobioreactors to be more prevalent, construction and operation costs must decrease. Cost aside, higher carbon dioxide concentration, temperature control, and light availability allow closed photobioreactors higher growth rates than open ponds.

1.4. THESIS OBJECTIVE

This thesis describes a geographically- and temporally-resolved, integrated biological and engineering model that estimates algal biomass and lipid production under resource-limited conditions with hourly and county resolution. To the author's knowledge, this model is the first analysis to estimate algal biomass production by integrating the geographic distribution and availability of resources with biological growth models. Resource limitations are an important consideration for algae growth because the necessary quantity and combination of resources are not always present in all geographic locations at all times. Four primary resources are considered in this model: sunlight, carbon dioxide, water, and land. The variation in quantity and distribution of these resources allows the rate of algae growth to be estimated and integrated for different growth locations and scenarios.

The rate-dependent nature of algae growth is described by several biological models, including a modified Monod growth model, and depends primarily on the intensity of incident solar radiation and carbon dioxide concentration. [11] Solar radiation varies both geographically and temporally, while carbon dioxide concentration can be used to model growth using ambient carbon dioxide (distributed throughout the state) or flue gas (at point sources in the state). The total annual potential biomass growth is determined at county resolution based on incident photons, carbon dioxide availability, water, and land. Finally, lipid production is calculated by assuming oil content based on dry weight of the biomass.

The model accommodates a range of growth and production scenarios, including water recycling, co-location with wastewater treatment plants and coal-fired generators, and photobioreactor setup (open pond or tubular photobioreactor), and use of atmospheric or anthropogenic carbon dioxide sources. The integrated model is used to calculate production for every county in Texas, but is demonstrated in greater detail for two counties in Texas with different quantities of resources for various carbon dioxide concentration and a range of water recycling fractions. Two counties are used to illustrate the tradeoffs and limitations between solar- and land-rich western counties, and carbon dioxide- and water-rich eastern counties. This analysis yields insight into the geographic distribution of potential algae production, which is dependent on the availability of resources and environmental growth conditions in each individual county. Aggregate results across a state or region are useful for providing an educated estimate about total quantities of biomass and lipids that can be produced. The authors believe that the methodology can be repeated and expanded to other biological feedstocks and other geographic regions.

Chapter 2: Geographic and Seasonal Variability of Resources

The resources required for algae growth vary both geographically and temporally. In particular, the four resources considered in this model (sunlight, carbon dioxide, water, and land), are not uniformly allocated across the state and can vary through the day or year. Unfortunately, their allocation is mismatched with optimal conditions: water and carbon dioxide are more abundant in the eastern half of the state, while sunlight and land are more abundant in the western half. It is not readily apparent based on this distribution of the resources where it is optimal to produce algae, nor the total potential production. In addition, it is not clear by looking at each of the resources individually to know which ones are the limiting factors for algae growth. However, incorporating the co-location of resources as demonstrated here allows for a more robust estimation of potential biomass production. Additionally, analyzing resources by county provides a useful resolution for planning purposes.

To illustrate this concept, the four resources have been compiled and displayed for Texas at the county resolution. Data were collected, normalized, and calculated for solar insolation, anthropogenic carbon dioxide production, and water availability (from major saline aquifers, wastewater treatment plants, and seawater) at multiple locations throughout Texas using a variety of sources and analytical techniques (see below for further description). Land availability has been estimated from agricultural census data and existing natural gas wellheads and oil pad sites. Figure 3 below displays each of the resources by county in Texas. As can be seen, resources vary county by county. Each of the resources is discussed in more detail in the following sections.

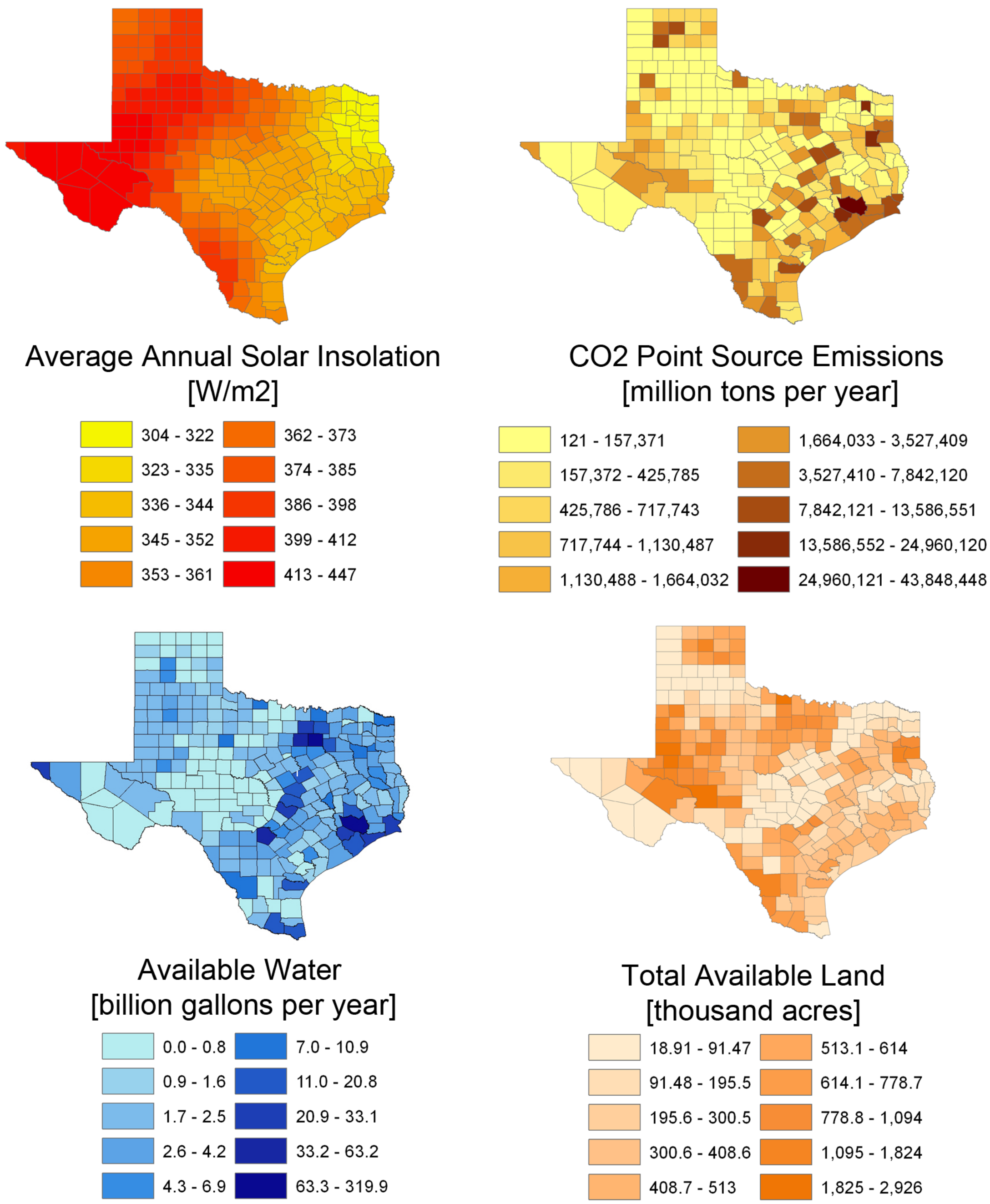

Figure 3. The distribution of resources pertinent to algae production vary significantly across the state. Solar insolation and land availability are generally higher in the west, while anthropogenic carbon dioxide and water resources are more abundant in the east. Upper left: average annual solar insolation; Upper right: anthropogenic carbon dioxide from point sources; Lower left: available water resources in billion gallons per year; Lower right: total land availability in thousand acres from oil and natural gas production sites and conservation land.

2.1. SOLAR RESOURCES

Data from several solar measurement sites have been collected and compiled using the methodology reported by Wogan et al. [24] The methodology for estimating the geographic and temporal solar radiation data is discussed in Section 3.3. A total of 24 measurement locations from the Texas Solar Radiation Database (TSRDB) and National Solar Radiation Database (NSRDB) are used in this analysis. [25, 26] Data from the TSRDB have been collected at one hour intervals from 2000 to 2003. The average daily, monthly, and annual radiation fluxes were calculated at each measurement site, neglecting nighttime measurements. Data from the NSRDB were obtained from the Typical Meteorological Year (TMY3) dataset. The TMY3 dataset contains monthly and annual radiation fluxes that typify a given region over a span of many years (e.g., 30 years). [27] Data from both sources were then interpolated across the state using an inverse-distance weighted approximation in ArcGIS to assign values for each county.

As expected, the western region of the state receives more solar radiation than the eastern portion, and the solar insolation is higher in July than December. Texas receives approximately 375 W/m^2 of solar radiation annually on average during daylight hours, which varies from an average of 308 W/m^2 in the eastern portion of the state to 448 W/m^2 in the western regions of the state. Note: most averages are reported for 24-hour periods but we report only for daylight hours.

2.2. CARBON DIOXIDE RESOURCES

Ambient carbon dioxide in the atmosphere and concentrated flue-gas carbon dioxide from stationary emitters can be used to grow algae. Atmospheric carbon dioxide is assumed to be evenly distributed throughout the state at a low concentration of approximately 385 ppm. Anthropogenic carbon dioxide is available form stationary emitters such as power plants at very specific locations and with a typical concentration of 12 to 14 percent by volume. Figure 3 depicts carbon dioxide emissions of stationary sources in Texas by county. Carbon dioxide output from power plants in Texas were tabulated geographically.

Data on carbon dioxide emissions were obtained from the U.S. Energy Information Agency and the Vulcan Project from Purdue University. [28, 29] Carbon dioxide emissions are located mostly near major population centers, including the Houston area, the San Antonio-Austin-Dallas corridor and a few locations in the Texas Panhandle. The entire state of Texas produces approximately 409 million metric tons of carbon dioxide per year from stationary power emitters and industrial sources. [28, 30]

2.3. WATER RESOURCES

Unlike terrestrial plants, algae can utilize saline or brackish water as long as pH levels are maintained during growth. Because of concerns about freshwater scarcity and algae's compatibility with degraded water, the only water resources that are considered available for the model includes the combined total of water from underground saline aquifers, wastewater from municipal treatment plants, and water from the sea (for coastal counties). The saline aquifer withdrawal rates represent the amount of water that can be physically withdrawn from a well without depleting the aquifer, as determined by the Texas Water Development Board. [31] Major saline aquifers can potentially produce approximately 249 billion gallons of water per year in a sustainable fashion. Much higher rates of withdrawal are possible, but doing so would deplete the aquifers.

Wastewater data were obtained from the Texas Commission on Environmental Quality. [32, 33] Over 3.2 billion gallons of wastewater are treated daily (approximately

1.2 trillion gallons per year). Right now these flows are returned to waterways, but could potentially be available for algae production. Combined with wastewater, Texas has the potential to supply over 1.4 trillion gallons of water each year that is suitable for algae growth. Overall, the United States uses approximately 36 trillion gallons of water per year for all purposes. [34] Figure 3 depicts the total estimated water available in Texas by combining available wastewater flow rates and major saline withdrawal rates.

In addition to the groundwater and wastewater reserves, seawater from the Gulf of Mexico could potentially provide water for algae growth. For coastal counties, seawater is treated by the model as an unlimited resource. As seen in Figure 3 above, water resources vary dramatically across the state. Major metropolitan areas typically have more water resources (due to wastewater treatment plants) than rural counties. Generally speaking, eastern and central Texas contains greater water resources than west Texas.

2.4. LAND

The available land suitable for algae growth has been estimated using three types of land: agricultural land currently in conservation, land dedicated to oil and natural gas production, and agricultural land currently in production. Conservation land is agricultural land currently not utilized for agricultural or other development purposes. [35] Conservation land has been utilized as one proxy to estimate the amount of land theoretically available for algae production because it represents agricultural land that is relatively flat and presumably suitable for placement of ponds or photobioreactors, but is currently unused. The USDA 2007 Census of Agriculture has been used to obtain conservation land estimates. [35] These values provide an upper limit to non-urban land that does not compete with crop or livestock production. As shown in Figure 4, conservation land varies across the state. Counties in the panhandle region have greater land available for algae growth than counties in urban and metropolitan areas.

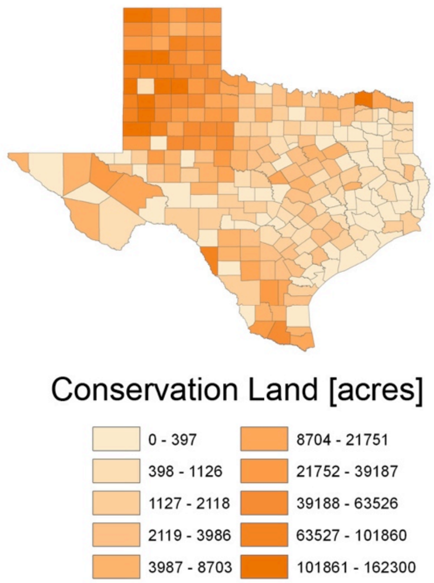

Figure 4. Conservation land in acres.

Oil and natural gas wells provide another estimate of land that is potentially available for algae production. These sites are located throughout the state and represent land the public has traditionally been comfortable with dedicating for fossil fuel energy production. Our analysis assumes that a similar amount of land could be dedicated for algal biomass production without popular resistance. Based on data obtained from the Texas Railroad Commission, 388,532 acres of land could be available for algal biomass production, assuming 1 acre per land for each 388,532 oil and natural gas sites. As seen in Figure 5, land from oil and natural gas production is located primarily in the western portion of the state.

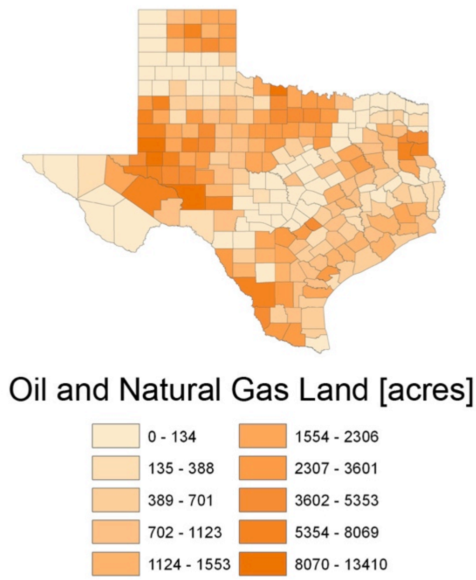

Figure 5. Oil and natural gas land is located primarily in west Texas.

Agricultural land currently in use represents an upper bound to algae production. While using agricultural land for algae production would compete with livestock or crop production, it does provide a useful scenario for understanding how much biomass can be produced on land that is already used. Based on data obtained from the USDA, over 121 million acres of agricultural land exists in Texas. [35]

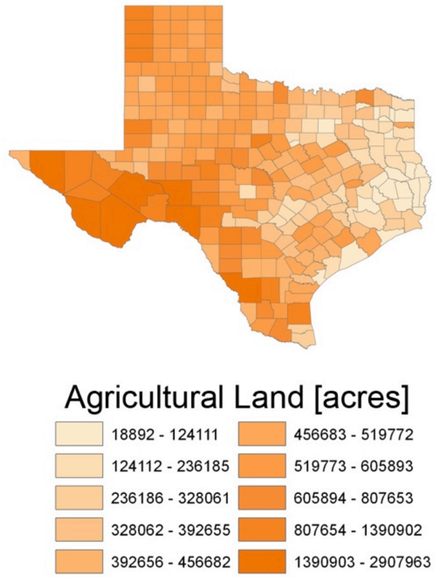

Figure 6. Over 121 million acres of agricultural land are distributed through Texas.

Chapter 3: Methodology For Calculating and Reporting Geographically- and Temporally-Resolved Solar Radiation Measurement Data

3.1. INTRODUCTION

Solar energy is becoming more important as the world considers alternative sources of energy. [36-44] And, comprehensive solar radiation data are instrumental for making informed decisions about solar-based electricity generation capacity or the potential for agricultural and biofuel crops. [45] There are numerous solar radiation measurement sites and approaches around the country and world, including land-based measurements, satellite-based measurements performed by the National Renewable Energy Laboratory (NREL), and by other secondary models. [41] While a significant amount of prior work and databases relevant to solar energy are scientifically rigorous, the data are typically not presented in a convenient format for researchers, policy-makers or consumers. For example, the solar data for a given region are often located in separate databases for individual geographic locations with different time periods, terminology, and units, and are not aggregated into a single convenient database. [46, 47]

This section describes a methodology and framework for calculating, compiling and reporting measured solar radiation data in a convenient format. We suggest that solar information can be made more accessible to decision-makers (including homeowners, researchers, policy-makers, etc.) by aggregating and including the temporal and geographic variations of measured data. We demonstrate the reporting framework and methodology using Texas as an illustrative case study. The estimated solar insolation (average and peak W/m^2) and total energy ($kWh/m^2/day$) are reported at the county level in Texas and are compatible with geographic information systems (GIS) making them convenient for subsequent analysis (for example, to calculate the potential for solargenerated electricity or energy crop growth by location and month). This format and resolution is valuable for studies that depend on the co-location of geographically variable resources. [48-52] Research efforts in Canada and Europe have presented solar radiation data for the estimation of electricity production in a similar manner, but the raw solar data are often contained within web-based tools and are not directly available to researchers or consumers. [52, 59, 60] The proposed methodology and framework seeks to overcome this problem and is configured in a way that can be expanded to larger geographic regions.

The purpose of this analysis is not to supersede other solar energy research activities, but to outline a framework for reporting and compiling solar data using previously measured data that is compatible with GIS tools and accessible by the public. It is the authors' intent that other researchers will find the methodology and data helpful in their respective fields and endeavors.

3.2. DATA SOURCES

Texas has been chosen as a case study for this work because of its geographic and seasonal variation and availability of physical solar measurements. A total of 24 measurement locations were used in this analysis. Figure 7 displays the measurement locations in Texas. Primary data points have been obtained from the Texas Solar Radiation Database (TSRDB) at The University of Texas at Austin. [53] The TSRDB has 15 measurement sites located throughout Texas that measure global, direct and diffuse horizontal radiation at intervals ranging between 5 minutes to an hour. All 15 TSRDB locations are used in this analysis. TSRDB measurements were taken using rotating shadowband pyranometers (RSPs). The measurements are reported on the TSRDB website and described in the literature [54]. These data serve as the basis for spatial interpolation across the remaining 239 counties in Texas.

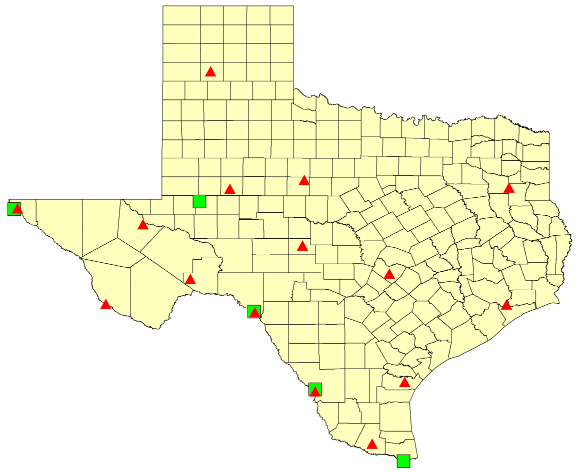

Figure 7. Twenty-four measurement sites were used to estimate solar insolation in Texas. TSRDB sites are marked with red triangles; NSRDB sites are marked with green squares. Out of state NSRDB locations are not shown for clarity.

Of the 15 measurement locations, 11 sites provided hourly power flux (W/m^2) data: Abilene; Austin; Canyon; Clear Lake; Corpus Christi; Edinburg; Menard; Overton; Pecos; Presidio and Sanderson. Data at each location were obtained for the years 2000-2003 to provide a consistent sample of the radiation received in Texas. At a few locations, several hours or days worth of data are missing due to malfunctioning equipment or heavy storm activities. In these cases data from another year in the set were used as replacements. Hourly insolation data were not available from the TSRDB at the following four sites: Big Spring, Del Rio, El Paso and Laredo. For these locations, only monthly $kWh/m^2/day$ were obtained from published TSRDB data in the literature. [54]

Data from the National Solar Radiation Database (NSRDB), run by the National Renewable Energy Laboratory, have been compiled into hourly global, direct and diffuse radiation from several years to form one representative year. [55] These locations provided additional data points at neighboring sites that aided in interpolation by forming a boundary around Texas. [41] These locations are: Brownsville, TX; Lake Charles, LA; Ponca City, OK; Oklahoma City, OK; and Albuquerque, NM. Several Texas sites measured by the NSRDB were used in this analysis to supplement lack of hourly data for the four TSRDB sites. These locations are: Del Rio; El Paso; Midland; and Laredo.

This combination of twenty-four measurement locations provided sufficient data points to interpolate solar radiation across the state with reasonable gradation, and in a way that yields county-level first-order estimates of insolation (see below for further discussion). However, it is possible that solar variations on smaller geographical scales due to micro-climates or other phenomena are not accurately resolved. This number of measurement sites were selected primarily because of the availability of data because of the existing measurements. If more measurement sites become available in the future, the proposed framework is robust enough to accommodate the additional information, which would presumably yield improved geographical fidelity. Such an addition to the data set would be a desirable improvement.

3.3. METHODOLOGY

The goal of this analysis is to utilize the geographic and temporal variation in solar radiation data across the state at the county resolution. A numerical routine was written to process the data and calculate daily, monthly and annual values for average and peak W/m^2 and $kWh/m^2/day$ for global, direct and diffuse horizontal radiation. Once averages for each location were calculated, the values were projected onto a map using a geographic information system where the values could be interpolated spatially to non-measurement sites. These data are provided in tables, maps and figures.

3.3.1. Calculating Average and Peak W/m^2

For the 11 sites with hourly data, average W/m^2 were calculated by totaling the insolation and number of daylight hours in each day. These totals were then used to create averages for each day, month and year. Because the data span four years (2000-2003), an average of the four years was taken to get a representative set of data. Data for the four Texas locations lacking hourly data were replaced with NSRDB locations: Del Rio; El Paso; Midland; and Laredo. Peak insolation values were determined by finding the maximum radiation flux in each day.

The five NSRDB sites outside of Texas were incorporated to provide external data points required for interpolation. Daily, monthly and annual averages and peak values were calculated from these data in the same manner as the Texas-based measurements.

3.3.2. Calculating kWh/m^2/day

In order to calculate the amount of energy available at each site, hourly solar flux values in W/m^2 were integrated over the course of each day at each site using a trapezoidal integration of the hourly data spanning three years. The integration results provided daily averages of the solar energy density in kWh/m^2/day that were used to calculate average kWh/m^2/day at monthly and annual time periods. The integration was performed for the 11 TSRDB and 5 NSRDB measurement locations; total energy data were reported by the TSRDB for Big Spring, Del Rio, El Paso and Laredo and therefore did not need any further processing.

A detailed look at the measured global insolation for Presidio, TX, which receives some of the highest solar radiation in the state is shown in Figure 8 to illustrate the proposed reporting framework. A glossary of useful terms is presented in Table 2.

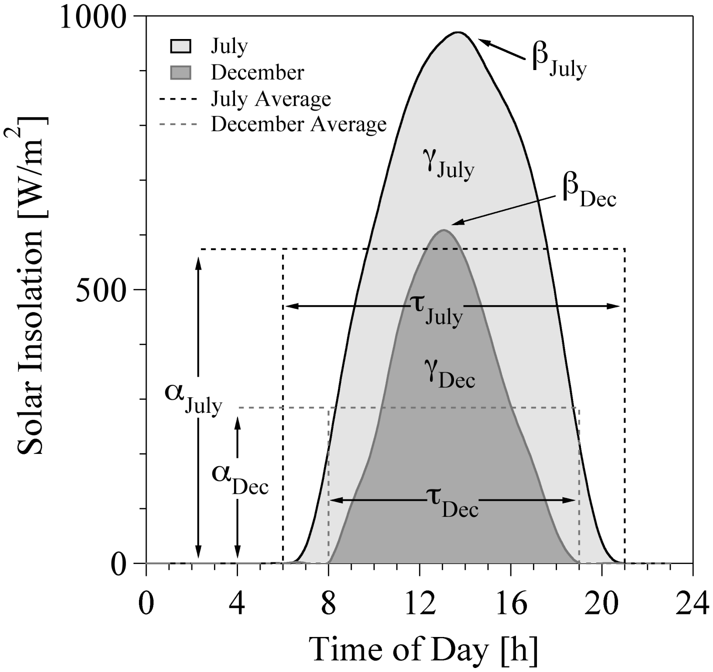

Figure 8. Hourly solar insolation in W/m^2 for Presidio, TX is depicted during July (black line) and December (gray line). The area under the curves represent the total solar energy received each day.

Table 2. Glossary of terms used in reporting framework.

Term	Definition
α	Average insolation [W/m^2]
β	Peak insolation [W/m^2]
γ	Total energy [kWh/m^2/day]
τ	Number of daylight hours [h]

Two curves are presented in Figure 8: hourly solar radiation in W/m^2 for July 17 in black and December 31 in gray. As is expected, the hourly radiation received in Presidio in July is greater than in December, with peak insolation for July 36 percent higher than in December. The average daily values are also plotted with July receiving 101 percent more solar radiation per day on average than in December. The area under the two curves represents the total amount of energy per day: 8.0 $kWh/m^2/day$ in July and 3.4 $kWh/m^2/day$ in December.

A point of interest illustrated by these two datasets is the variation in daylight hours for both months. The amount of usable daylight hours increases from 11 hours in December to 15 hours in July – the highest in the year. This information is useful for predicting availability of solar radiation at different times during the year. As shown above, the variations can be significant. This analysis has computed the average daily values by utilizing only daylight hours. If the solar insolation were averaged over 24 hours the average would drop by approximately 30 percent to 40 percent, which would present an artificially low estimate of available radiation during peak times. Many prior publications present the overall average, but we find that format to be less clear about the temporal aspects of solar energy because it does not reveal the variability from month to month.

3.3.3. Geospatial Interpolation

Once the average, peak and total energy values were calculated, they were assigned to geographic locations and projected onto maps using ArcGIS. First, values at each of the 20 locations were mapped according to the latitude and longitude of the measurement locations. The average, peak and total energy data at the individual measurement locations were then spatially interpolated in ArcGIS to the rest of the state by using an inverse-distance weighted method. Inverse distance-weighting has been used in similar studies to estimate solar radiation from data at sparsely located sites. [56-58] Inverse distance-weighting was performed using a second power interpolation and values from 12 neighboring locations (counties in this analysis). The power used in inverse distance-weighted interpolation controls the importance of known points compared to the interpolated values based on the distance between the two. As the power is increased, the interpolated value reaches the nearest neighbor approximation where values in close proximity to the known points approach the same value. The default power is 2. The number of neighboring locations was varied from 12 to 24 to determine an appropriate value. The number of locations was chosen to be 12 because the interpolation results provided a regional distribution instead of pockets of values representing individual measurement locations.

The interpolation resulted in a raster layer with each interpolated value represented by a pixel. In order to determine the values at the county level, the raster layer was analyzed using the Zonal Statistics function in ArcGIS. Mean, Median, and standard deviation were calculated based on the raster data in each county. The resulting mean values were then assigned to each county in dataset layers where they can now be displayed on a series of maps. This process was performed for all monthly and annual values of average, peak and total energy data.

3.3.4. Sources of Error

Several sources of error are present from both the measurement data and the interpolation method. Errors associated with the measured TSRDB apply directly to the 11 measurement locations within the state boundary utilizing hourly power flux data. According to an analysis of the TSRDB measurements, the average annual global total energy, γ, differs from satellite-derived data by 3 percent across all measurement locations in the state. [54] However, TSRDB and NSRDB data deviate at individual measurement locations; annual measurements for Austin (central Texas) are approximately 9 percent lower than NSRDB values while annual Pecos (west Texas) measurements are 8 percent higher. [54]

The deviation between the calculated and satellite-derived data can possibly be explained by the geographic separation of the TSRDB measurement locations. The measurement locations are spaced approximately 150 miles apart and do not take solar microclimates into account. The solar radiation can vary with bodies of water (e.g., near the Gulf of Mexico) or in rocky and mountainous terrain (e.g., western portions of the state). According to the TSRDB data, variation between satellite-derived data and the TSRDB measured data are estimated up to 20 percent near coastal regions with most error within 13 percent. Changing weather patterns and other atmospheric conditions could introduce unexpected errors, but data spanning multiple years was chosen to minimize these effects. [54]

Additionally, errors are encountered in the interpolation method and variables (power, number of neighboring locations) chosen. In particular, the number of measurement locations chosen for interpolation affects the overall resolution of the analysis. The 15 TSRDB locations are chosen for this analysis because they are readily available and broadly dispersed across the state. The remaining 9 locations are used to fill in gaps in data and provide a boundary for the interpolation. The quality of the calculated values has been validated by comparing the interpolated values against satellite-derived solar radiation maps provided by NREL. The interpolated values fall within the published range of values for the satellite-derived data. [41] While the current amount of interpolation points appears to be sufficient, additional data points are expected to reduce the error of the interpolated values by accounting for more solar microclimates and other variations. As additional data points come available, the framework is robust enough to accommodate them.

3.4. INTERPOLATION RESULTS

The interpolated results have been presented on maps of Texas at the county resolution and in tabular form. Figure 9 depicts the average kWh/m^2/day for the months of December and July across the state. These two months represent extremes of incoming solar radiation. As shown in Figure 9 (left), the amount of solar energy in December varies from 2.39 kWh/m^2/day in the eastern portion of the state to 3.59 kWh/m^2/day in the western regions. In July, radiation varies between 5.89 and 7.9 kWh/m^2/day.

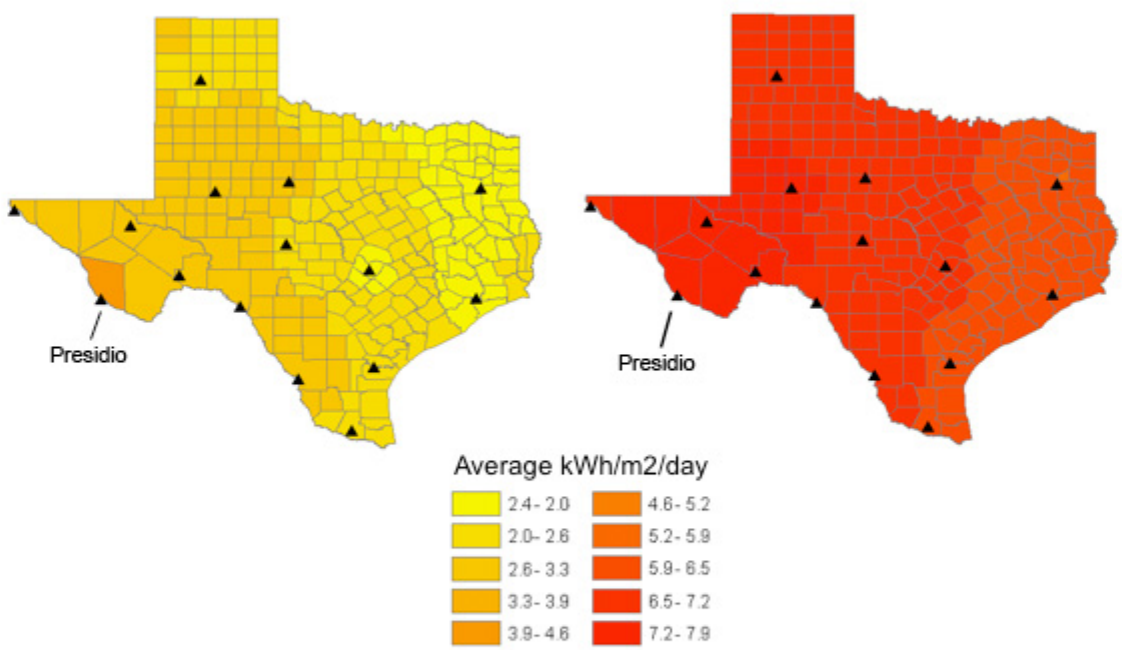

Figure 9. (left) Average kWh/m^2/day in December for Texas. (right) Average kWh/m^2/day in July for Texas. Measurement locations are marked with triangles.

The interpolated monthly and annual peak and average W/m^2 and kWh/m^2/day for global, direct and diffuse horizontal radiation at each county in Texas are presented in Tables 11 - 13 (see Appendix B). Average W/m^2 are represented by α, peak W/m^2 by β and total energy in kWh/m^2/day by γ. Please note that total energy can also be expressed in kWh/m^2/year by multiplying γ by 365. The average number of daylight hours per month for each county is listed in Appendix B. These values were also interpolated from the 11 TSRDB sites, represented by τ.

Chapter 4. Background Theory (Biological Kinetics and Biology)

4.1. BIOLOGICAL MODELING

Algae growth can be estimated by the Monod growth model, which was initially developed in 1949 by Claude Monod to model the growth of bacterial cultures. [11] It has been modified throughout the years to incorporate additional variables and environmental conditions that affect culture growth. The environmental conditions included in this model are available solar radiation intensity, carbon dioxide concentration in the algae broth, and various constants that govern carbon uptake rates in the algae. This analysis uses the following version of the Monod model [59] :

$$\mu = \mu_{\max}\left(\frac{G_{av}}{G_{av}+K_G}\right)\left(\frac{C_{tot}}{K_C+C_{tot}+C_{tot}^2/K_I}\right) \qquad \text{(Eqn. 1)}$$

μ is the algal growth rate, or specific growth rate, which has the units of inverse time (1/s or 1/h). [13] A higher specific growth rate indicates a system that takes less time to reproduce and double its mass. The actual growth rate can be a function of many parameters (temperature, mixing, light-dark cycling, etc.), but is assumed to be only a function of incident light and carbon dioxide concentration in this model. This assumption is embedded in the modified Monod model used by Berberoglu *et al*. [60]

The maximum specific growth rate, μ_{max}, is determined experimentally and can be used to capture temperature effects of a culture; G_{av} is the available amount of light available within the reactor expressed in W/m^2; K_G is the half-saturation constant of light (W/m^2); C_{tot} is the total amount of dissolved carbon (liquid phase) in the reactor (kmol C/m^3); and K_C and K_I are the half-saturation and inhibition constants for carbon (kmol C/m^3). [60] The constants K_G, K_C, and K_I vary by species and have been determined experimentally in the literature. [61] The dissolved inorganic carbon concentration (liquid phase), C_{tot}, is calculated based on the transfer of carbon dioxide (gas phase) into the broth. These variables represent the algae's overall response and growth dynamics well enough to represent the general growth behavior. Therefore different growth rates can be achieved by varying the amount of incident light and initial carbon dioxide concentration.

The solar radiation intensity drives the photosynthesis process and can vary by region and time of year. The amount of available photons within the photobioreactor, G_{av}, is calculated by accounting for the attenuation of photons as they pass through the algae broth. The attenuation depends on the algal cell density, reactor dimensions and incident light intensity. This relation is represented by the following integral:

$$G_{av} = \frac{1}{L}\int_0^L G_{in} \exp\left(-E_{Ext,PAR} X z\right) dz \qquad \text{(Eqn. 2)}$$

where G_{in} is the spectral irradiance incident on the reactor (W/m^2), represented by daily, monthly, or annual averages. [60] Additionally, $E_{ext,PAR}$ is the photon extinction coefficient, X is the biomass concentration (kg/m^3), and z is the depth of the photobioreactor. The photon extinction coefficient accounts for the photosynthetically active region (PAR), which are the wavelengths between 400 and 700 nm available for photosynthesis. [62] Upon integration using the photobioreactor depth, from $z = 0$ to L, we arrive at:

$$G_{av} = \frac{1}{L}\left[-\frac{G_{in}}{E_{ext}X} * \exp(-E_{ext}XL) + \frac{G_{in}}{E_{ext}X}\right] \qquad \text{(Eqn. 3)}$$

As expected, the amount of photons in the photobioreactor decreases exponentially with increasing reactor depth.

Algae growth has been shown to vary with carbon dioxide concentration, ranging from atmospheric concentrations (0.038 percent) to higher concentrations typical of power plant flue gas (12-14 percent). [63, 64] For these reasons, carbon dioxide concentration can be varied in this model to alter the amount of carbon that is dissolved into the water and eventually taken up by the algae. While the literature suggests that optimal growth is possible at concentrations higher than atmospheric levels, [9, 73-77] the optimal carbon dioxide concentration used in this model is 0.05 mole fraction (5 percent), in order to stay consistent with the other assumptions incorporated into this model from the literature.

The total amount of dissolved carbon in the liquid phase, $C_{tot,}$ depends on the initial molar fraction of carbon dioxide supplied to the reactor and can be represented by the following relation:

$$C_{Tot} = 10^{-1.5} x_{CO_2,g} + \left(\frac{10^{-7.8}}{10^{-pH}}\right) x_{CO_2,g} + \left(\frac{10^{-28.1}}{10^{-2pH}}\right) x_{CO_2,g} \qquad \text{(Eqn. 4)}$$

where the pH is the pH of the growth medium and $x_{CO2,g}$ is the initial molar fraction of carbon dioxide. [60, 65] The amount of dissolved carbon depends on the pH and initial molar carbon dioxide concentration of the air, or gas being bubbled through the photobioreactor. This model assumes that the liquid and gas phases are at quasi-equilibrium, as noted by Berberoglu *et al*. [60] This assumption is important and indicates that algae growth is not limited or impeded by the amount of carbon that can be dissolved into the algae broth.

4.2. BIOLOGICAL KINETICS

In general, algae growth can be described by four phases: lag, exponential growth, linear growth and death. [12] A reactor is typically initiated with a culture of algal cells and nutrient media. The alga cells do not immediately begin reproducing and instead take time to adapt to their new environment. This time period is referred to as the lag phase. Once the alga cells have adapted to their environment they begin growing at an exponential rate until they become limited by the lack of a given resource or nutrient. This behavior is called the exponential growth phase. The algae continue to grow until all of the resources and nutrients are consumed, which marks the beginning of the death phase. [13]

Only the exponential growth phase is considered in this model. This model assumes that the algal culture has been inoculated and has had sufficient time to adapt to the growth conditions. It is assumed that the algae will be removed continually from the reactors before reaching the latter growth stages (linear growth and death). The exponential growth phase is represented as the time rate of change of the cell density in the culture,

$$\frac{dX}{dt} = \mu X, \qquad \text{(Eqn. 5)}$$

where X is the cell concentration of the algae in kg dry cell/m^3 and μ is the specific growth rate of the algae in h^{-1}. [13, 14] The biomass produced at a given time t is found by integrating Equation 5 for the final cell concentration $X(t)$:

$$X(t) = X_0 \exp(\mu t). \qquad \text{(Eqn. 6)}$$

4.2.1. Effect of changing initial cell concentration, X_0

The initial cell concentration plays an important role in the growth of alga cultures. A low initial cell concentration is inefficient at capturing and converting photons into biomass and lipids because many of the photons do not interact with the alga cells and are wasted as heat energy instead. Alternatively, a very high initial biomass can prevent the culture from developing because individual alga cells can block out sunlight, preventing cells from growing. [66] As shown by Equation 3 earlier, increasing the initial cell concentration decreases the average irradiance available in the reactor because the alga cells attenuate photons as they pass through the reactor. Mixing has been shown to improve the light distribution for dense algal cultures. [41] Other considerations such as light-dark cycling and mixing rates become important in these conditions. [67] This model assumes that the reactors are well-mixed and that the effects of light-dark cycling on growth are optimal. [68]

4.2.2. Effect of changing initial carbon dioxide concentration and light intensity on growth rates

The variation of light intensity and carbon dioxide concentration can represent a wide range of growing conditions and directly affects the algae growth in this model. Increasing light intensity reduces the doubling-time, meaning the algae grow faster. [41] While it is appealing to increase growth rate by increasing the amount of photons incident upon the algal cells, the culture can only grow to a certain concentration because photons will become attenuated near the surface due to the creation of a dense culture and self-shading. [66, 69]

Increased photon fluxes can also damage or burn the alga cells. As the amount of incident photons increases, the alga cells become saturated and are unable to utilize the photons for photosynthesis. The excess photons can then damage or burn the alga cells. This phenomenon, called photoinhibition, can be observed in many climates during the summer where grass and trees turn brown because of high photon fluxes (in addition to drought conditions). [70] The extent of photoinhibition can be calculated by varying the incident light in Equation 2.

In addition to light intensity, the carbon dioxide concentration can potentially affect growth rates. The effect of carbon dioxide concentration on growth rates varies by species and strain, but in general, algae grow faster at higher carbon dioxide concentrations. [60, 71-73] Experiments published in the literature have successfully grown algae at carbon dioxide concentrations up to 100 percent, although optimal and fastest growth rates have been reported for concentrations up to 5-20 percent. [10, 74] The results in the literature are specific to certain alga species and growth conditions.

4.2.3. Effect of temperature on growth

The effect of temperature on biomass growth is assumed to be negligible in this model even though biomass growth does in fact depend on temperature of the growth medium. [75, 76] Since the objective of this research is to demonstrate the feasibility of integrating dynamic growth models with special resolution based on the geographic variation of four input resources, temperature effects were neglected for this work to simplify the number of environmental conditions and modeling of the algal kinetics while retaining the overall behavior of biomass growth.

The temperature effects would normally be included by inclusion in the maximum specific growth rate term, μ_{max}, in Equation 1. As the temperature increases or decreases the specific growth rate would change ultimately affecting the overall growth rate, μ. However, this model seeks to demonstrate the general behavior of algae growth for a wide range of species with spatially- and temporally-resolved resource availability – not for individual species. [77-79] Therefore, it is assumed that temperature effects are negligible through the use of controls placed on reactor systems. Though such temperature controls have been demonstrated for some parts of an algae production system, it's quite possible such controls might prove to be prohibitively expensive. Temperature effects are important, future versions of this methodology might integrate the temporal variability of temperature on top of the spatial variability of resources.

Both higher and lower temperatures can affect biomass growth rates because the chemical processes that constitute cell growth and nutrient uptake are altered. [77] The outdoor tests conducted by the National Renewable Energy Laboratory (NREL) in the 1980s experienced stunted growth rates due to cool nighttime temperatures in open pond systems. [64] High temperatures can arise in both outdoor ponds and tubular photobioreactors, but are more severe in the latter. As seen in the NREL tests, temperatures in open ponds can fluctuate a great deal because heat can be lost very easily from a large, exposed surface such as a pond.

Tubular reactors tend to increase in temperature because excess photons are converted into waste heat. A greenhouse is a common example of this type of heating. Energy contained within the photons is converted to heat energy and is trapped within the greenhouse, much like the heat trapped inside the tubular photobioreactor by the algal broth.

Chapter 5: Model Methodology

The model estimates algal biomass production by determining the quantity of algae that can be grown for a set of available resources in a region (in this case by county) and at different times (monthly variation). First, the growth rate is determined from the intensity of solar insolation and carbon dioxide concentration; higher growth rates result in increased resource consumption. Solar insolation varies throughout the year and across geographies. Carbon dioxide concentration can be manipulated to represent a variety of carbon dioxide sources; flue gas from a power plant has a higher concentration of carbon dioxide than ambient air, which affects growth rates. After the growth rate is determined, the total quantity of biomass and lipid production is estimated by determining which resources limit production. The resource constraints are calculated using average ratios for algae production based on quantities of photons, carbon dioxide, water, and land.

Algae growth productivity is typically reported in terms of either biomass dry weight per square meter (kg/m^2) or biomass per unit of volume (kg/m^3). This model calculates productivity on a per volume basis (kg/m^3), which illustrates the amount of water and resources used to produce a given amount of biomass. Higher biomass concentrations are more desirable in a system and indicate a productive algal culture. The total amount of algal biomass produced is calculated for a given time period (typically monthly or annually) and has the units of tons of biomass per year (tpy).

The individual steps are discussed in more detail in the following sections. A schematic of the model's logic, sequence, inputs, and outputs is presented below.

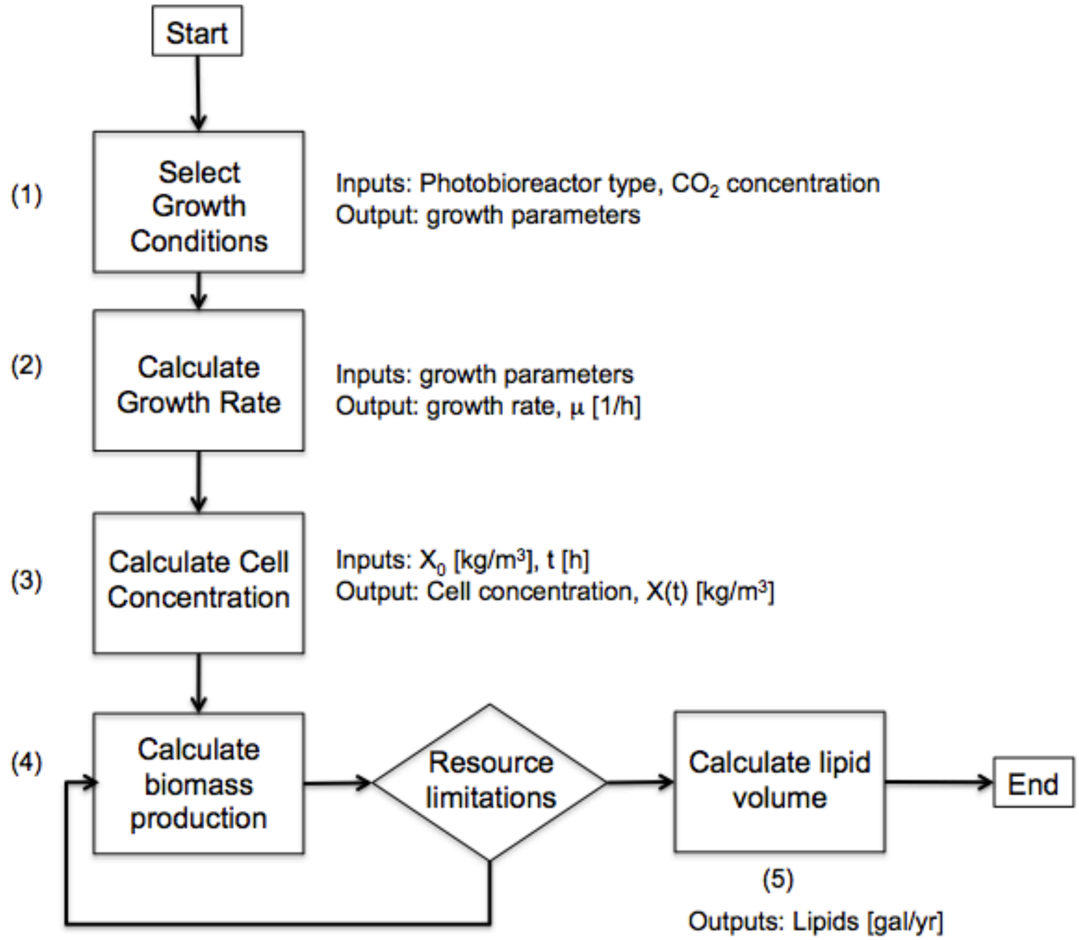

Figure 10. Flow diagram of the integrated biological and engineering algae growth model.

5.1. STEP 1: SELECT GROWTH CONDITIONS

First, the growing conditions must be specified for the model. There are two types: physical and biological. The physical conditions include the photobioreactor type (either open ponds or tubular systems) and the carbon dioxide concentration (either ambient or flue gas). Flue gas from power plants has been suggested as a source of inorganic carbon for algae growth because of its abundance and the algae's ability to sequester large amounts of carbon. [9, 71, 72, 77] The flue gas would most likely need to be mixed with air before being distributed to reactors to achieve optimal growth rates because typical power plant flue gas contains between 12 percent and 14 percent carbon dioxide. The carbon dioxide concentration can be varied in the model to represent the different carbon dioxide sources.

The biological conditions include the growth constants discussed above in the background theory section. Other variables that affect the growth rates are the sunlight intensity, which is determined by the amount of photons incident on the reactor (see Eqn. 3), the maximum specific growth rate (μ_{max}), and initial algae concentration (X_0). The typical values for constants and parameters used in this model are shown in Table 3 and are used in Step 2.

Table 3. Parameters and constants used in the Monod model.

Parameter	
Initial carbon dioxide concentration (molar fraction)	0.0038 - 0.019
μ_{max} [1/h]	2.4
X_0 [kg/m^3]	0.5
x_{CO2} [mole fraction]	0.005
pH	7.0
L (open pond, tubular) [m]	0.3, 0.06
E_{ext} [m^2/kg]	350
K_G [W/m^2]	13.32
K_C [kmol C/m^3]	0.0002
K_I [kmol C/m^3]	0.0182
Oil Content [percent]	0.25
Oil Density [kg/m^3]	920

5.2. STEP 2: DETERMINING THE TIME-RATE OF CHANGE

Once the initial conditions and parameters are set, the model estimates the time rate of change, μ, of the algae growth according to Equation 1 and values in Table 1. The time rate of change represents how quickly the algae grow and reproduce under a set of conditions. Larger values for the growth rate, μ, indicate increased productivity. The growth rate μ is used in Step 3 to determine growth over a period of time.

5.3. STEP 3: DETERMINE CELL CONCENTRATION AT A SPECIFIED TIME PERIOD

After the instantaneous growth rate, μ, of algae has been determined for a given set of physical conditions, the volumetric biomass production over a time period, $X(t)$ can be calculated according to Equations 5 and 6. Daily volumetric biomass production is the desired output, which means that t = 24 in Eqn. 6. The volumetric biomass production is used in Step 4.

5.4. STEP 4: CALCULATE BIOMASS PRODUCTION UNDER RESOURCE CONSTRAINTS

The maximum biomass production can now be determined by calculating the minimum production from a single resource. In other words, the minimum quantity produced by any one resource is the maximum biomass production possible. First, the initial biomass production is estimated using the available water flow rate ($\dot{V}_{add}$) and biomass concentration, $X(t)$. The available flow rate ($\dot{V}_{add}$) is essentially make-up water used to replenish water consumed during photosynthesis. The quantity of biomass produced from the flow rate of available water represents an upper bound to algae production, because regardless of the availability of the other resources, growth will be constrained by the water required for photosynthesis. The biomass production from the remaining three resources is then calculated and compared with the initial biomass production. In the event that another resource results in a smaller quantity of biomass, the new quantity becomes the updated upper bound of biomass production. The process is performed for photons, carbon dioxide, and land.

Ratios are used to estimate biomass production for photons, carbon dioxide, and land. The ratios and yields used in this model are presented in Table 4. The individual resources are discussed in the following sections.

Table 4. Ratios and yields for resource constraints.

Yield/Ratio	
Land	
Open Pond [m^3/m^2]	0.3
Tubular reactor [m^3/m^2]	0.047
Solar Energy	
Algae growth from photons [kJ/g]	21.9
Carbon Dioxide	
Algae growth from carbon dioxide [kg biomass/kg CO_2]	0.567
Water	
Consumption during photosynthesis [kg biomass/m^3]	1380
Water recycle fraction (F) [fraction]	0-0.99

5.4.1. Solar Energy

The biomass produced solely from solar energy can be calculated based on the energy content of the biomass. The energy content of algae has been determined to range between 20-24.0 kJ/g based on experimental results published in the literature. [92-94] The energy content varies by algal strain, growth conditions, and composition (carbohydrates, lipids, and proteins). This model assumes average biomass energy content of 21.9 kJ/g as published by Weyer et al. This assumption leaves out the upper and lower bounds for algae production solely by solar energy, but is useful for representing a range of species at the time the algae are harvested. [80] The solar energy available for photosynthetic processes is assumed to be the average irradiance G_{avg} calculated in Equation 2. The available solar energy is calculated using average daily solar insolation for each month (as described in Chapter 3).

5.4.2. Carbon dioxide

The total carbon dioxide resources available in a given region are a potential constraint. As seen in Equation 4 above, carbon dioxide is taken up by the algae and stored in the biomass. This model assumes that 0.567 kg of algal biomass is produced for every kg of carbon dioxide consumed. This value represents the average of carbon uptake rates at different stages of algae growth, as explained in the literature. The value is calculated by relating the production of biomass to consumption of carbon through the following relation:

$$Y_{\frac{X}{C}} = M_{CO_2} Y_{\frac{X}{CO_2}} \qquad \text{(Eqn. 7)}$$

where M_{CO2} is the molecular weight of carbon dioxide (44 kg/kmol) and $Y_{X/C}$ is equal to 24.96 kg biomass/kmol carbon. [60, 61] This carbon dioxide yield agrees with published values from the literature. [21, 81]

5.4.3. Land

While algal biofuels are appealing because of their relatively small land footprint, land constraints are an important consideration when modeling potential production. The areal footprint of photobioreactors depends on whether an open pond or tubular system is employed. On average, open pond systems can supply 0.3 m^3 of broth water per square meter of area, while tubular systems are more productive at 0.047 m^3 of broth per square meter.

5.4.4. Water

Water availability is used to calculate the initial biomass production. The volume of water required consumed during photosynthesis is calculated using the same procedure for carbon dioxide (see section 5.4.2. above). Using the molecular weight of water (M_{H2O}=18) yields 1380 kg of biomass per cubic meter of water. The available water resources can be extended through the use of water recycling. Water recycling allows a large amount of algae to be grown using a small initial volume of water. Instead of discarding the broth after the algae have been harvested, a fraction of water can be reused in the photobioreactor. The fraction of water recycled in the system depends on biomass harvesting techniques, availability of water supplies, and other technical and economic constraints. This model incorporates water recycling using a variable fraction of water recycle to model different scenarios. Figure 11 depicts a typical photobioreactor utilizing water recycling.

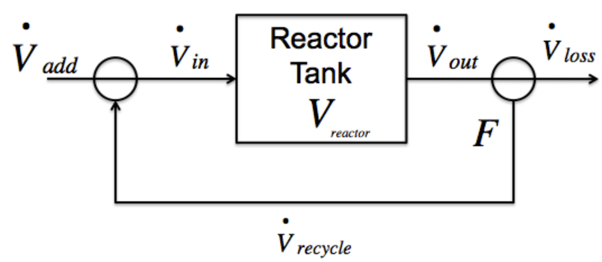

Figure 11. Water recycling for a typical photobioreactor reduces the amount of water needed to make up for evaporative and process losses in the system.

The goal of water recycling is to reduce the amount of water that is needed to make up for evaporative and process losses in the system. A flow of water enters the photobioreactor as $\dot{V}_{in}$ and exits as $\dot{V}_{out}$. A fraction of the outlet water can be returned back into the photobioreactor as $\dot{V}_{recycle}$. The $\dot{V}_{loss}$ term represents water consumed during the photosynthesis process, lost to evaporation, or discarded from the system. Under steady state operation the water lost to these activities is made up from the available water resources as $\dot{V}_{add}$. The water recycling is modeled as a typical feedback loop:

$$\dot{V}_{in} = \frac{\dot{V}_{add}}{(1-F)} \qquad \text{(Eqn. 7)}$$

The recycle fraction, *F*, can be varied from 0 percent (F=0, no recycling) to 99 percent (F=0.99, maximum recycling). The recycle fraction is intentionally limited to 99 percent to account for water consumption during photosynthesis. That is, it is not feasible to recycle 100 percent of the water because a small portion must be consumed by the algal culture.

5.5. STEP 5: CALCULATE LIPID PRODUCTION

Lipid production is calculated using assumptions of lipid content within algal biomass and the fraction of useful lipids. Taken together, these terms represent the cell oil content, which is the fraction or portion of the cell that can be processed into a useful biofuel. [80] The cell oil content varies with algae strain and growth conditions. Following the methodology presented by Beal *et al*, the oil content and percentage of useful lipids are understood to be variable based on production techniques, growth conditions, and more. [82]

The literature suggests that algae strains can contain as little as zero percent oil up to approximately 70 percent oil by mass. [21, 80, 83-85] This model assumes cell oil content to be 20 percent by mass. This value was chosen because sustainable algae production with yields higher than 20 percent by mass have not been demonstrated, whereas lower levels might not be economical. [83] While many factors affect the production of lipids in an alga cell, the oil content assumed by the model represents a realistic, yet optimist expectation of lipid content in an average alga cell. The total volume of oils produced can be estimated using the density of the algal oil, which is assumed to be similar to soybean oil at 920 kg/m^3. [86, 87]

5.6. MODEL ASSUMPTIONS

The model estimates algal biomass production by analyzing the environmental conditions and resources available in a given region. Primary resources required for algae growth and incorporated in the model are solar radiation flux (W/m^2), carbon dioxide (either atmospheric, or anthropogenic), water (from either saline or brackish water), and land. Nutrient limitations are not included in this analysis.

Two typical reactor designs are analyzed: open pond systems and tubular photobioreactors. Open-pond systems are currently in use today for producing algae for nutritional supplements and because of their rather simple design and construction have trouble controlling against temperature fluctuations and contamination from the environment. Tubular photobioreactors, while more expensive, typically offer more control over the algal culture. Tubular photobioreactors are commonly clear tubes that allow for thorough light distribution, control over pH levels, and protection against contaminants. [88, 89]

The volumetric productivity (kg dry cell/m^3-day) is used to compare the model results with experimentally determined results for a range of alga species and growth conditions. Dimensions for the reactor dimensions used in the model are presented in Table 5 below.

Table 5. Pond and tubular photobioreactor dimensions used in the model. [21]

Parameter	Pond	Tube
Width (m)	12	-
Length (m)	82	80
Diameter (m)	-	0.06
Depth (m)	0.30	-
Volume (m^3)	295	0.23
Areal footprint (m^2)	984	4.8

The model does not specify a specific strain of alga for the analysis, but instead bases its estimates from general characteristics that encompass some common strains of alga that are relevant for biofuels production. This approach allows the model to represent a wide range of species and growth techniques without selecting species or production processes. For example, the median biomass energy content is utilized in the model instead of a range of values across multiple species grown in different ways. While information is lost, the median value provides a convenient estimate of common quantities of algal species.

Chapter 6. Results & Discussion

A number of interesting results can be calculated using the model. Below, three different results are discussed: statewide monthly and annual lipid production; sensitivity to land type; and a resource comparison between two counties. Statewide results are useful for providing aggregate lipid production estimates while individual county production estimates illustrate the nuances of limiting constraints and sensitivities to resource availability. The production estimates and resource sensitivities statewide and by county are discussed in more detail below.

6.1. OVERALL LIPID PRODUCTION

Statewide monthly and annual total lipid production has been calculated for an open pond system utilizing atmospheric carbon dioxide. The model considers four types of land (as discussed previously) using a range of water recycling fractions: zero water recycling (F=0), 50 percent (F=0.5), and 90 percent (F=0.9). The results were calculated by determining a daily lipid production rate (gal/day) for each month, which are then multiplied by the number of days per month. The annual result is the summation of the monthly production totals for F=0, F=0.5, and F=0.9. The four land scenarios are:

I. Conservation land. This scenario represents the second smallest amount of land available in Texas.

II. Oil and natural. This scenario represents the smallest amount of total available land in Texas.

III. Conservation and oil and natural gas land. This scenario combines both conservation and oil and natural gas land.

IV. Agricultural land currently in use. This scenario represents an upper bound for algae production using an amount of land currently employed for agricultural use in Texas.

The results of these scenarios are presented in Table 6-8.

Table 6. Monthly and total annual lipid production for four types of land in million gallons for F=0. Atmospheric carbon dioxide was used in an open pond reactor for these results.

Type	Land [million acres]	J	F	M	A	M	J	J	A	S	O	N	D	Annual
I	4.1	9.5	9.0	10.0	10.8	11.4	11.1	11.6	11.5	10.8	10.1	9.2	9.1	124.9
II	0.4	9.3	8.9	10.2	10.5	11.0	10.7	11.2	11.0	10.5	9.9	9.1	8.9	121.5
III	4.5	12.2	11.6	13.3	3.6	14.3	13.9	14.6	14.4	13.6	12.9	11.9	11.8	158.2
IV	121.7	17.8	16.7	18.9	19.1	20.1	19.5	20.3	20.1	19.1	18.6	17.3	17.3	225.1

Table 7. Monthly and total annual lipid production for four types of land in million gallons for F=0.5. Atmospheric carbon dioxide was used in an open pond reactor for these results.

Type	Land [million acres]	J	F	M	A	M	J	J	A	S	O	N	D	Annual
I	4.1	17.0	16.3	18.8	19.2	20.4	19.8	20.7	20.5	19.3	18.3	16.6	16.4	223.4
II	0.4	16.4	15.8	18.3	18.8	19.9	19.3	20.2	19.9	18.8	17.6	15.9	15.7	216.7
III	4.5	22.8	21.7	24.9	25.4	26.8	25.9	27.1	26.9	25.4	24.2	22.3	22.0	295.5
IV	121.7	38.3	35.6	33.4	37.9	38.3	40.2	39.0	40.7	40.3	38.3	37.2	34.6	415.4

Table 8. Monthly and total annual lipid production for four types of land in million gallons for F=0.9. Atmospheric carbon dioxide was used in an open pond reactor for these results.

Type	Land [million acres]	J	F	M	A	M	J	J	A	S	O	N	D	Annual
I	4.1	70.5	61.8	59.8	69.6	71.7	76.6	74.5	77.7	76.8	71.9	66.5	60.1	59.1
II	0.4	47.6	46.8	54.9	57.7	61.8	59.9	63.2	62.2	58.0	52.4	46.4	45.0	655.9
III	4.5	80.1	77.4	90.2	93.4	99.7	96.9	101.2	99.9	93.8	86.5	77.9	76.5	1,073.5
IV	121.7	178.1	166.7	189.9	191.3	201.2	195.0	203.3	201.3	191.3	185.8	173.1	173.8	2,250.9

Both time during the year and land availability affect algae growth, and subsequently, lipid production. In general, the minimum algae growth occurs in the winter (December) and increases to a maximum in the summer (July). These results suggest that the intensity of solar insolation and quantity of solar energy affect algae growth. While more photons are available in summer months, the intensity of solar insolation has a larger affect on algae production by increasing the growth rate (μ), which ultimately allows more algae to be grown in the summer months. Water, carbon dioxide, and land resources are constant throughout the year.

In each of the above cases, increasing land or water recycling fraction does not result in a linear increase in lipid production. This result occurs because the resources are distributed unevenly throughout the state, and an increase in land statewide does not correspond to an equal increase in land for each county. Even with an increase in available land, lipid production can be limited by other resource constraints in individual counties.

Because it is assumed that the water, land, and carbon dioxide do not change much annually, they are assumed to be constant. However, because solar insolation changes daily and seasonally, the effect of solar insolation on lipid production in individual counties can be explored by calculating percentage standard deviation. The standard errors have been calculated using standard statistical routines in data processing software (Excel) and expressed in terms of percentage changes (standard error/minimum lipid production). The percentage standard errors for all 254 counties using atmospheric carbon dioxide, open pond reactors, and conservation land are presented as a load diagram in Figure 12.

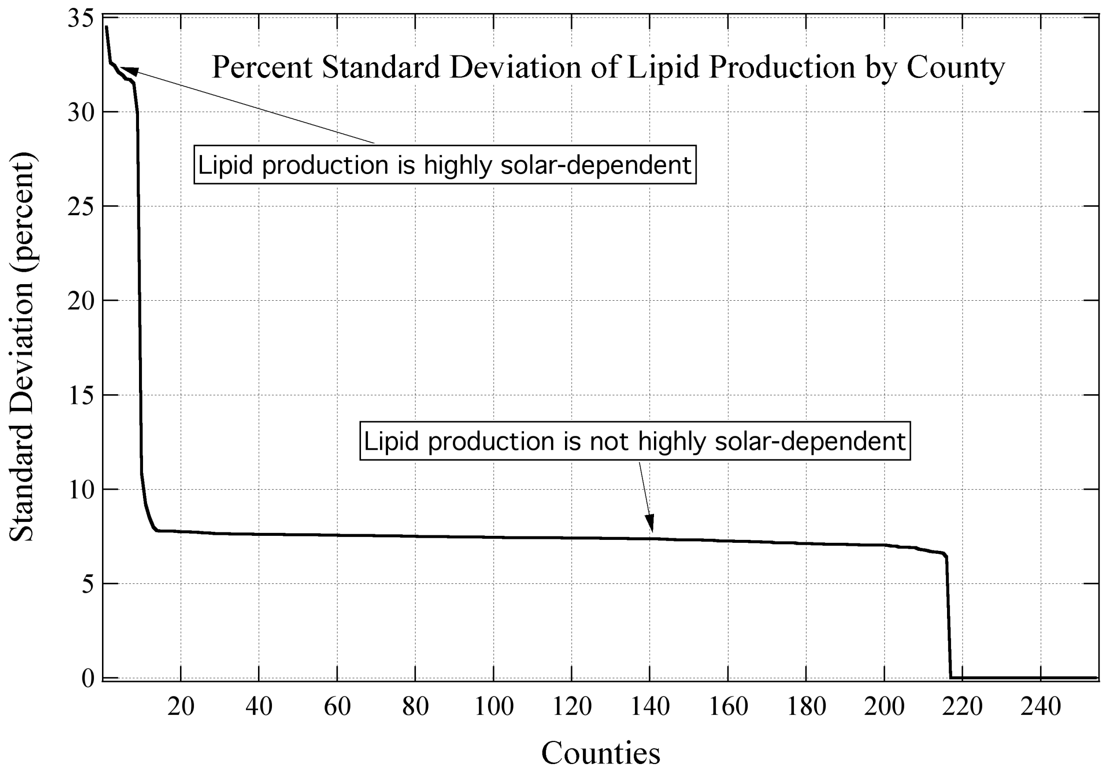

Figure 12. Variation of county lipid production as a function of solar insolation.

The standard deviations have been sorted from greatest percentage standard deviation to least (left to right, respectively). Counties exhibiting large percentage standard deviation experience large variations in solar insolation throughout the year, while counties with small percentage standard deviation do not experience large variations. Furthermore, because solar insolation is the only variable resource, the results suggest that counties with greatest standard deviation are more dependent on solar insolation than counties without large standard deviations. The counties experiencing the greatest variation (above 30 percent) are located primarily in major metropolitan counties (e.g., Harris, Bexar, Tarrant, and Dallas counties). Counties with the least (or zero) variation are land limited and not solar-dependent.

6.2. SENSITIVITY TO LAND TYPE

The sensitivity to land availability can be seen by varying water recycling fraction, F, for a given month in a given county for two quantities of land. To illustrate, lipid production in Anderson county is estimated for F=0, F=0.5, and F=0.9 for both conservation and agricultural land in January. As seen in Table 9, lipid production is constant at water recycling fractions of F=0 and F=0.5 for both quantities of land. This result suggests that lipid production is water-limited. However, as the water recycling fraction is increased to F=0.9, land becomes a limiting factor.

Table 9. Lipid production varies based on available land and water recycling fraction.

Water Fraction (F)	Lipid Production (gal/month) - Conservation	Lipid Production (gal/month) - Agricultural
0	28,594	28,594
0.5	57,189	57,189
0.9	86,108	285,948

Growth is determined for the month of January, which eliminates the influence of solar insolation on lipid production. Additionally, atmospheric carbon dioxide sources are utilized to avoid being limited by anthropogenic carbon dioxide resources.

6.3. COUNTY COMPARISON (HIGH AND LOW RESOURCES)

To test the model's results for varying input conditions and geographic resource availability, several test cases were run using resource data for two counties in Texas (Rusk and Presidio). These counties provide an illustrative example of how algal biomass and lipid production varies as a function of available resources. Rusk County is located in East Texas and has significantly more water and carbon dioxide resources than Presidio County, despite having less than one-sixth the land mass of Presidio County. Presidio

County is located in West Texas and receives more solar radiation and has more land available than Rusk County, but contains few water and carbon dioxide resources. Resources for the two counties are presented in Table 10.

Table 10. Comparison of resources for two counties in Texas.

Resources	**Rusk (East Texas)**	**Presidio (West Texas)**
Daily average solar radiation for July (W/m^2)	398	524
Carbon dioxide (tons/year)	16,885,807	493
Water (million gallons/year)	2,989	124
Conservation land (million m^2)	2.7	18.1

Lipid production was calculated using the solar, carbon dioxide, water, and land resources for an open pond system in both counties while varying carbon dioxide concentration and water recycling fraction. The daily average solar radiation during July was chosen to represent the month of highest growth. The results of the analysis are shown below in Figure 13.

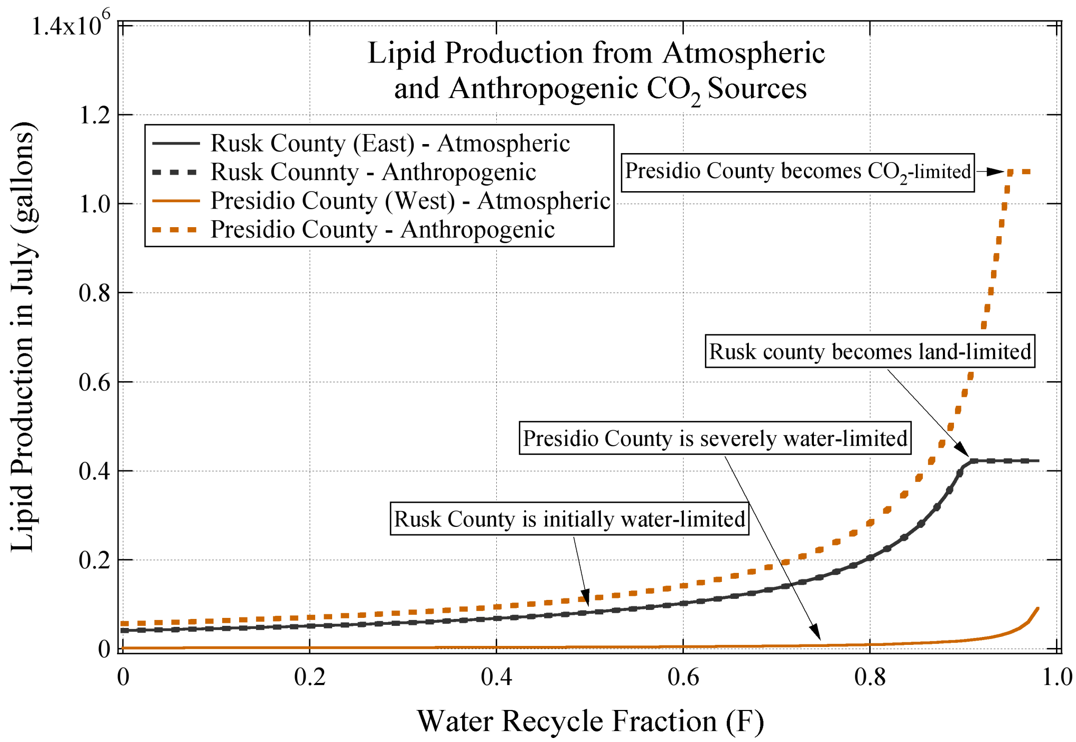

Figure 13. Lipid production varies as a function of water recycling fraction.

In Rusk County, a difference in lipid production is negligible between atmospheric and anthropogenic carbon dioxide sources. Rusk County contains more water and carbon dioxide resources than Presidio County, but lacks photons and available land. As shown by the black lines, lipid production increases as water recycling increases until roughly 90 percent water recycling (F=0.9) where production becomes limited by available land. This result suggests that increasing carbon dioxide does not always result in increased lipid production. In this example, Rusk County is limited by both water and land resources. Therefore increasing the carbon dioxide concentration will increase growth rates, but the growth is ultimately limited by water and land limitations.

In Presidio County lipid production differs dramatically between the atmospheric and anthropogenic scenarios. For the atmospheric scenario, lipid production slowly increases as the water recycling fraction increases until the recycling limit (F=0.99) is reached. Lipid production utilizing anthropogenic carbon dioxide sources not only starts out greater than the atmospheric scenario, but increases at a greater rate with increasing F. Lipid production eventually plateaus at 90 percent water recycling (F=0.9), where anthropogenic carbon dioxide resources become exhausted. The increase in lipid production as a result of higher carbon dioxide concentrations aligns with published results in the literature (discussed above).

These results display the significance of geographic and temporal resource distribution for algae production. Increasing the amount of land generally results in increased biomass and lipid production. The sensitivity to individual resources at the county level has been demonstrated for a range of water recycling fractions for two distinct counties (Rusk County in east Texas and Presidio County in west Texas), and for variation in solar radiation for all 254 counties.

Chapter 7. Summary

An integrated biological and engineering model has been developed to estimate algal biomass production for biofuels with geographical resolution under resource-limited conditions. Photons, carbon dioxide, water, and land resources have been included as potentially limiting resources required for algae production. The co-location and temporal variation of these resources have been integrated into a single analysis to provide a robust estimate of algal biomass growth and lipid production. The integrated model accommodates a range of growth and production scenarios, including water recycling, co-location with wastewater treatment plants and coal-fired generators, photobioreactor setup (open pond or tubular photobioreactor), and use of atmospheric or anthropogenic carbon dioxide sources. A methodology for interpolating and reporting geographically- and temporally-resolved solar radiation data was also created to provide data for the model.

Solar radiation data have been compiled and interpolated across all 254 counties in Texas using measured data from the Texas Solar Radiation Database and National Solar Radiation Database. Hourly, daily, monthly, and annual averages were calculated from the measured data using inverse distance-weighted interpolation. Water data were obtained for saline aquifers and wastewater treatment plant flow rates at locations across Texas. Carbon dioxide resources include both atmospheric concentrations (which are assumed to be unlimited for this analysis) and anthropogenic point sources at locations throughout Texas. Three different types of available land were considered: conservation land; land currently used for oil and natural gas production; and agricultural land currently in use.

The model estimates algal biomass production by determining the quantity of algae that can be grown for a set of available resources in a region (in this case by county) and at different times (monthly variation). First, the growth rate is determined from the intensity of solar insolation and carbon dioxide concentration; higher growth rates result in increased resource consumption. Solar insolation varies throughout the year and across geographies. Carbon dioxide concentration can be manipulated to represent a variety of carbon dioxide sources; flue gas from a power plant has a higher concentration of carbon dioxide than ambient air, which affects growth rates. After the growth rate is determined, the total quantity of biomass and lipid production is estimated by determining which resources limit production. The resource constraints are calculated using average ratios for algae production based on quantities of photons, carbon dioxide, water, and land as found in the literature.

Several scenarios have been tested to illustrate the sensitivity of lipid production to geographic and temporal resource limitations. Results for every county in Texas indicate that between 86 million and 2.2 billion gallons of lipids per year can be produced statewide for the various growth scenarios. The analysis suggests that algal biomass and lipid production does indeed vary geographically and temporally across Texas. Overall, most counties are water-limited for algae production, not sunlight or carbon dioxide-limited, and increasing the amount of land generally results in increased biomass and lipid production.

However, there are many nuances in biomass and lipid production for individual counties. Varying carbon dioxide concentration results in higher growth rates, but not always increased biomass and lipid production because of other resource limitations in each county. The sensitivity to individual resources at the county level has been demonstrated for a range of water recycling fractions for two counties: Rusk County in eastern Texas and Presidio County in west Texas. Counties in west Texas are typically not solar- or land-limited, but are constrained by either water or carbon dioxide resources. Consequently, counties in eastern Texas are limited by either water or land (depending on the fraction of water recycling). Biomass growth is also dependent on the variation in solar radiation and has been demonstrated for all 254 counties by calculating the standard deviation of biomass production for a given month using average daily solar insolation.

The results of this model are useful for engineers, biologists, policy-makers, and others who are interested in understanding how the geographic and temporal distribution of resources affects biofuel production.

Appendix A: MATLAB Code

A.1. SLIMER RUN FILE

```
%
% Last modified 10/13/10
% Next steps:
%  -display limiting resource?

clear all
clc

% Open file and assign inputs
fid = fopen('Slimer_Resources.txt'); % open the data file
inputs = textscan(fid, '%s%n%n%n%n%n%n%n%n%n%n%n%n%n%n%n%n%n%n%n',
'Headerlines',1); % store inputs into an array
fclose(fid)

iterations = length(inputs{2});

month_array = [31; 28; 31; 30; 31; 30; 31; 31; 30; 31; 30; 31]; % used
to sum up lipids in each month

F = 0.0; % can modify this if needed, but can also run the
Slimer_F_run.m script


% Run for ATMOSPHERIC CO2
atmosphere = 1;

%Run for POND
pond = 1;

% different land cases with COUNTER "c"
for c=1:4
    land_data = inputs{1,16+c}; % [m2] 17 - conservation; 18 - oil/NG;
19 - Ag; 20 - conservation + oil/NG

    % go through each county with COUNTER "j"
    for j=1:iterations
        water_data = inputs{1,16}(j);
        CO2_data = inputs{1,15}(j);
        available_land = land_data(j);

        % calculate biomass for each month using COUNTER "m"
        for m=3:14
            solar_data = inputs{1,m}(j);
            results = Slimer_v3(solar_data, CO2_data, water_data,
available_land, F, pond, atmosphere);
            lipids(j,m-2)= results(1);
            monthly_lipids(j,m-2) = results(1)*month_array(m-2);
```

```
        end
    end
    output{c,1} = monthly_lipids;
    output{c,1}(:,13) = lipids*month_array; % annual sum
    output{c,1}(:,14) =
(std(monthly_lipids')'./(min(monthly_lipids')'))*100; % percentage std
dev of growth
end


% Run for TUBE
pond = 0;

% different land cases with COUNTER "c"
for c=1:4
    land_data = inputs{1,16+c};

    % go through each county with COUNTER "j"
    for j=1:iterations
        water_data = inputs{1,16}(j);
        CO2_data = inputs{1,15}(j);
        available_land = land_data(j);

        % calculate biomass for each month using COUNTER "m"
        for m=3:14
            solar_data = inputs{1,m}(j);
            results = Slimer_v3(solar_data, CO2_data, water_data,
available_land, F, pond, atmosphere);
            lipids(j,m-2)= results(1);
            monthly_lipids(j,m-2) = results(1)*month_array(m-2);
        end
    end
    output{c,2} = monthly_lipids;
    output{c,2}(:,13) = lipids*month_array; % sum total lipids in one
year
    output{c,2}(:,14) =
(std(monthly_lipids')'./(min(monthly_lipids')'))*100; % percentage std
dev of growth
end



% ----- ANTHROPOGENIC ------

% Run for ANTHROPOGENIC CO2
atmosphere = 0;

%Run for POND
pond = 1;

% different land cases with COUNTER "c"
for c=1:4
    land_data = inputs{1,16+c};

    % go through each county with COUNTER "j"
```

```
    for j=1:iterations
        water_data = inputs{1,16}(j);
        CO2_data = inputs{1,15}(j);
        available_land = land_data(j);

        % calculate biomass for each month using COUNTER "m"
        for m=3:14
            solar_data = inputs{1,m}(j);
            results = Slimer_v3(solar_data, CO2_data, water_data,
available_land, F, pond, atmosphere);
            lipids(j,m-2)= results(1);
            monthly_lipids(j,m-2) = results(1)*month_array(m-2);
        end
    end
    output{c,3} = monthly_lipids;
    output{c,3}(:,13) = lipids*month_array; % sum total lipids in one
year
    output{c,3}(:,14) =
(std(monthly_lipids')'./(min(monthly_lipids')'))*100; % percentage std
dev of growth
end


% Run for TUBE
pond = 0;

% different land cases with COUNTER "c"
for c=1:4
    land_data = inputs{1,16+c};

    % go through each county with COUNTER "j"
    for j=1:iterations
        water_data = inputs{1,16}(j);
        CO2_data = inputs{1,15}(j);
        available_land = land_data(j);

        % calculate biomass for each month using COUNTER "m"
        for m=3:14
            solar_data = inputs{1,m}(j);
            results = Slimer_v3(solar_data, CO2_data, water_data,
available_land, F, pond, atmosphere);
            lipids(j,m-2)= results(1);
            monthly_lipids(j,m-2) = results(1)*month_array(m-2);
        end
    end
    output{c,4} = monthly_lipids;
    output{c,4}(:,13) = lipids*month_array; % sum total lipids in one
year
    output{c,4}(:,14) =
(std(monthly_lipids')'./(min(monthly_lipids')'))*100; % percentage std
dev of growth
end

disp('Done!');
```

```
% dlmwrite('output.txt',biomass,'delimiter','\t','precision', 8)
```

A.2. SLIMER VARIABLE WATER RECYCLING RUN FILE

```
%
% Last modified 10/13/10
% Next steps:
%  -display limiting resource?

clear all
clc
disp('Ready...');
disp('Set...');
disp('Go!');

tic;

% Open file and assign inputs
fid = fopen('Slimer_Resources.txt'); % open the data file
inputs = textscan(fid, '%s%n%n%n%n%n%n%n%n%n%n%n%n%n%n%n%n%n',
'Headerlines',1); % store inputs into an array
fclose(fid)

iterations = length(inputs{2});

month_array = [31; 28; 31; 30; 31; 30; 31; 31; 30; 31; 30; 31]; % used
to sum up lipids in each month

% Run for ATMOSPHERIC CO2
atmosphere = 0;

%Run for POND
pond = 1;

% go through the counties with COUNTER "j"
for j=1:iterations
    water_data = inputs{1,16}(j);
    CO2_data = inputs{1,15}(j);
    available_land = inputs{1,17}(j); % run analysis for conservation
land. can be changed
    F=0;
    i=1;
    for F =0:0.01:0.99
        for m=3:14
            solar_data = inputs{1,m}(j);
            results = Slimer_v3(solar_data, CO2_data, water_data,
available_land, F, pond, atmosphere);
            lipids(i,m-2)= results(1);
            monthly_lipids(i,m-2) = results(1)*month_array(m-2);
        end
        i=i+1;
    end
    output{j,1} = monthly_lipids;
    output{j,1}(:,13) = lipids*month_array; % annual sum
```

```
    output{j,1}(:,14) =
(std(monthly_lipids')'./(min(monthly_lipids')'))*100; % percentage std
dev of growth
end

toc;
disp('Done!');
```

A.3. SLIMER FUNCTION FILE

```
function results = Slimer_v3(solar_data, CO2_data, water_data,
available_land, F, pond, atmosphere)

% SLIMER biological growth model v1
% Last modified 2 February 2010
%
% This program receives environmental growth conditions such as carbon
% dioxide concentration, incident sunlight, and pH.

% clear all
% clc
%
% % Open file and assign inputs
% fid = fopen('test_data.txt'); % open the data file
% inputs = textscan(fid, '%s%n%n%n', 'Headerlines',1); % store inputs
into an array
% fclose(fid)
%
% iterations = length(inputs{2});
%
% solar_data = inputs{2};
% CO2_data = inputs{3};
% water_data = inputs{4};
% available_land = 1200; % m2 - will populate with real data

% Part I - Modified Monod Model

%Constants
umax = 2.4; % 1/d
Xo = 0.5; % kg/m3
pH = 7.4; % pH

if pond ==0
    L = 0.06; % [m] tube Berberoglu
    r_type = 2;
else
    L = 0.30; % [m] pond Pulz
    r_type = 1;
end

Eext = 350; % m2/kg
KG = 13.32; % W/m2
KC = 0.0002; % kmol C/m3
KI = 0.0182; % kmol C/m3
oil_content = 0.20; % percentage dry weight
oil_density = 920; % kg/m3 from Miao (2004) "High Yield..." & "High
Quality Biodiesel production from a Chlorella  p. ..." - Xu, also Weyer

% Variable Inputs
% Carbon dioxide concentration and amount
```

```
if atmosphere == 0
    xCO2 = 0.005; % mole fraction CO2
else
    xCO2 = 0.000385; % atmospheric
    CO2_data = 1e100;
end
Gin = solar_data; % W/m2

% F = 0; % fraction of water recycle


%Calculated intermediate variables
Ctot = xCO2*10^(-1.5)+xCO2*(10^(-7.8)/10^(-pH))+xCO2*(10^(-28.1)/10^(-
pH));
Gav = (1/L)*((-Gin/(Eext*Xo)*exp(-Eext*Xo*L)+(Gin/(Eext*Xo)))); % W/m2
u = umax*(Gav/(Gav + KG))*(Ctot/(KC+Ctot+Ctot^2/KI)); % 1/d

% Part II - Solving growth kinetics

%Solving dX/dt
t = 1; % growing time [d]
X = Xo*exp(u*t); % daily growth concentration [kg/m3]
td = log(2)/u; % doubling time [d]

% Part III - Initial Total Biomass Production

v_add = water_data/264; % available water [m3/day] used to be
water_available
v_in = v_add/(1-F); % calculate flow rate of water (depends on fraction
of recycle)
initial_growth = v_in*X; % [kg/day]


% Part IV - Calculate H2O and CO2 consumption and adjust production (if
% needed)

yield_CO2 = 24.96/44; % kg of biomass/kg of CO2 consumed
yield_H2O = 1380; % kg biomass/m3 H2O for photosynthesis
yield_photons = 21.9; % Joules/kg [Weyer]
water_consumed_for_growth = initial_growth/yield_H2O;
F_max = 1 - (water_consumed_for_growth/v_add);
CO2_consumed = initial_growth/yield_CO2; % kg of CO2 consumed for
intital biomass growth
% land_required_ratio = [0.03,0.30]; % m3/m2 of land required - pond,
tube from Pulz
land_required_ratio = [0.3,0.047]; % m3/m2 of land required - pond,
tube from Pulz

% array of consumed resources

photon_energy_available = Gav*available_land*64800; % Joules/day
growth_from_photons = photon_energy_available/yield_photons; % kg/day
of biomass from photons
CO2_available = CO2_data; % kg/day of CO2 available
```

```
growth_from_CO2 = CO2_available*yield_CO2; % kg of biomass based solely
on carbon dioxide
% growth_from_land = X*available_land*land_required_ratio(r_type); % kg
growth based on land
growth_from_land = u*X*available_land*land_required_ratio(r_type); % kg
growth based on land
% growth_from_land = 1000000000; % made up value


initial_growth_from_resources = [initial_growth; growth_from_photons;
growth_from_CO2; growth_from_land];
maximum_growth = min(initial_growth_from_resources); % minimum growth
from resources, kg/day

% calculate lipid production
lipid = (maximum_growth*oil_content/oil_density)*264.17; % gallons/day


% % calculate resources consumed based on growth from limiting resource
%
% v_tank_new = maximum_growth/X; % m3 of water for limited growth
%
% CO2_consumed_new = maximum_growth/yield_CO2; % kg/day of CO2 consumed
for limited growth
% land_used = v_tank_new/land_required_ratio(2); % m2
%
% water_photosynthesis = maximum_growth/yield_H2O; % m3/day water
consumed from photosyntehsis
% water_evaporation = 0; % m3 water lost due to evaporation
% makeup_water = water_photosynthesis + water_evaporation; % m3 total
makeup water required
%
% resource_array = [v_tank_new; makeup_water; CO2_consumed_new;
land_used];
%
% productivity = u*X; % kg/m3/d

% results = [maximum_growth; lipid; resource_array; productivity]; %
need lipids
results = lipid;
```

Appendix B: Solar Interpolation Tables

Table 11. Estimated monthly and annual averages of global radiation by county in Texas. Average W/m^2 are represented by α, peak W/m^2 by β and total energy in kWh/m^2/day by γ. Average daylight hours are estimated by τ.

	Jan				Feb				Mar				Apr				May				Jun				Jul				Aug				Sep				Oct				Nov				Dec				Annual			
County	α	β	γ	τ	α	β	γ	τ	α	β	γ	τ	α	β	γ	τ	α	β	γ	τ	α	β	γ	τ	α	β	γ	τ	α	β	γ	τ	α	β	γ	τ	α	β	γ	τ	α	β	γ	τ	α	β	γ	τ	α	β	γ	τ
Anderson	235	518	2.6	10.9	286	411	3.3	11.3	305	385	3.9	12.2	363	398	4.9	12.2	392	462	5.6	13.1	389	477	5.7	12.6	417	463	6.2	13.6	406	390	5.7	12.9	376	526	4.9	12.3	289	508	3.5	11.7	238	567	2.7	11.3	204	536	2.2	11.0	321	536	4.2	11.6
Andrews	292	452	3.3	10.5	354	375	4.2	10.8	419	408	5.2	12.1	467	434	6.3	12.0	516	456	7.1	12.4	502	455	7.1	12.3	518	343	7.4	12.4	480	448	6.5	12.2	456	471	5.8	12.2	359	450	4.4	11.2	306	376	3.4	10.9	279	348	3.1	10.5	420	348	5.4	12.0
Angelina	240	536	2.6	10.9	287	450	3.3	11.3	313	389	4.0	12.0	374	397	5.0	12.2	399	495	5.7	13.0	405	479	5.8	12.4	419	450	6.2	13.4	407	388	5.7	12.7	380	478	4.9	12.2	302	499	3.6	11.6	247	582	2.8	11.3	211	546	2.3	11.0	327	546	4.3	11.3
Aransas	247	510	2.7	11.2	288	432	3.4	11.0	319	484	4.0	11.1	381	546	5.0	11.5	408	505	5.9	11.6	419	413	6.1	11.4	434	390	6.4	11.3	421	447	5.8	11.2	403	379	5.2	11.1	312	626	3.8	11.3	261	593	3.0	11.5	234	547	2.6	11.3	342	547	4.5	11.0
Archer	273	500	2.9	10.5	318	448	3.7	10.5	365	398	4.6	11.0	427	460	5.7	10.9	456	519	6.5	11.4	455	528	6.6	11.4	470	436	6.9	11.5	462	497	6.4	10.8	421	508	5.4	10.9	316	508	3.8	11.1	265	495	2.9	11.0	239	485	2.6	10.4	371	485	4.8	10.5
Armstrong	279	482	2.9	10.1	323	510	3.8	10.1	381	480	4.7	10.3	446	514	6.0	10.5	474	500	6.8	10.6	466	489	6.8	10.9	494	523	7.1	10.3	460	577	6.3	10.8	440	585	5.7	10.8	326	562	3.8	10.7	274	451	3.0	10.7	254	493	2.6	10.6	386	493	5.0	11.4
Atascosa	270	538	2.9	11.0	315	434	3.6	10.9	346	502	4.3	11.3	403	523	5.3	11.6	433	544	6.1	11.8	443	436	6.4	12.1	460	364	6.7	11.8	448	454	6.1	11.3	414	455	5.3	11.3	317	611	3.8	11.3	271	509	3.0	11.1	246	463	2.6	10.7	363	463	4.7	11.1
Austin	250	542	2.7	10.9	295	450	3.4	10.9	331	410	4.2	10.7	391	467	5.1	11.3	418	541	5.9	11.5	427	497	6.1	11.5	442	442	6.4	11.4	427	441	5.7	11.1	396	408	5.0	11.1	304	578	3.6	11.2	260	580	2.9	11.1	224	547	2.4	10.8	343	547	4.4	11.0
Bailey	285	506	3.1	10.2	337	502	4.0	10.4	395	486	4.9	11.1	454	517	6.1	11.2	490	521	6.9	11.4	480	513	6.9	11.5	500	473	7.2	11.3	469	552	6.4	11.4	445	566	5.7	11.4	339	536	4.0	11.0	288	471	3.1	10.8	265	479	2.8	10.5	401	479	5.1	11.1
Bandera	275	562	3.0	10.9	318	484	3.7	10.9	355	471	4.4	11.2	406	532	5.5	11.5	438	567	6.2	11.7	441	500	6.4	12.1	469	371	6.8	11.8	456	465	6.2	10.5	421	491	5.4	10.8	310	584	3.8	11.4	267	508	2.9	11.2	247	426	2.7	9.9	368	426	4.7	10.9
Bastrop	247	565	2.7	11.0	295	391	3.4	10.7	318	423	4.0	10.8	373	414	4.9	10.9	408	551	5.9	11.0	427	553	6.3	11.2	446	357	6.6	10.7	453	466	6.0	10.8	398	409	5.1	11.0	287	591	3.4	11.1	253	634	2.8	11.0	219	612	2.4	10.6	342	612	4.4	11.0
Baylor	274	513	3.0	10.6	325	464	3.8	10.6	372	393	4.7	11.0	430	457	5.8	11.0	461	529	6.6	11.5	459	537	6.7	11.5	475	435	7.0	11.5	464	506	6.4	10.9	428	527	5.5	11.1	314	525	3.8	11.1	271	513	3.0	11.1	245	510	2.6	10.6	376	510	4.9	11.3
Bee	248	503	2.7	11.2	289	424	3.4	11.0	317	483	4.0	11.1	381	550	5.0	11.4	408	510	5.9	11.5	417	412	6.1	11.4	433	372	6.4	11.3	421	447	5.8	11.2	403	389	5.2	11.1	309	638	3.8	11.3	261	598	3.0	11.5	235	551	2.6	11.4	342	551	4.5	11.0
Bell	252	552	2.7	10.9	300	404	3.4	10.8	328	413	4.1	10.9	383	426	5.1	11.0	417	545	6.0	11.2	431	539	6.3	11.3	450	367	6.6	11.0	451	458	6.1	10.8	403	432	5.2	11.0	294	577	3.5	11.1	256	604	2.8	11.1	224	572	2.4	10.5	345	572	4.5	11.2
Bexar	266	551	2.9	11.0	311	437	3.6	10.9	342	469	4.3	11.1	397	495	5.3	11.4	429	549	6.1	11.6	439	486	6.4	11.8	459	368	6.7	11.5	452	460	6.1	11.0	412	453	5.3	11.1	308	596	3.7	11.3	266	542	2.9	11.1	239	492	2.6	10.5	359	492	4.6	10.9
Blanco	255	562	2.8	11.0	302	416	3.5	10.8	330	429	4.1	10.9	383	447	5.1	11.0	418	552	6.0	11.1	432	541	6.3	11.4	454	359	6.7	10.9	454	462	6.1	10.6	405	438	5.2	10.9	293	586	3.5	11.2	256	602	2.8	11.1	227	559	2.5	10.3	349	559	4.5	11.5
Borden	286	486	3.1	9.7	346	430	4.0	10.1	412	415	5.1	12.4	466	460	6.2	12.1	520	496	6.9	12.8	517	492	7.0	12.3	522	384	7.3	12.8	472	479	6.3	12.5	451	505	5.6	12.5	364	495	4.4	11.0	310	434	3.4	10.3	273	411	3.0	9.7	420	411	5.2	11.1
Bosque	261	531	2.8	10.8	308	433	3.6	10.8	345	402	4.3	11.1	401	446	5.4	11.2	433	532	6.2	11.6	438	518	6.4	11.7	457	394	6.7	11.7	449	450	6.1	10.9	410	472	5.3	11.1	305	542	3.7	11.2	260	550	2.9	11.1	232	511	2.5	10.3	353	511	4.6	12.0
Bowie	242	508	2.6	10.7	289	416	3.3	11.1	312	390	4.0	12.1	375	401	5.0	12.1	401	463	5.7	13.0	401	474	5.8	12.5	423	459	6.2	13.5	414	397	5.8	12.7	380	517	4.9	12.2	296	486	3.6	11.6	241	544	2.7	11.2	208	514	2.3	10.8	326	514	4.3	10.9
Brazoria	243	532	2.6	10.7	287	482	3.2	10.8	329	370	4.1	10.1	394	494	5.2	11.2	417	555	5.8	11.3	418	501	5.9	11.2	432	518	6.1	11.0	403	438	5.4	10.7	386	379	4.8	10.9	303	594	3.6	11.1	260	586	2.9	11.1	217	560	2.3	11.0	339	560	4.3	11.2
Brazos	251	543	2.7	10.9	297	439	3.4	10.9	329	411	4.1	11.0	388	448	5.1	11.4	417	533	5.9	11.7	426	501	6.2	11.6	442	426	6.4	11.7	431	436	5.8	11.3	397	430	5.1	11.3	303	563	3.6	11.3	257	578	2.9	11.2	223	544	2.4	10.8	341	544	4.4	11.9
Brewster	312	624	3.6	11.2	379	636	4.5	11.2	444	630	5.6	11.9	469	650	6.5	12.3	515	655	7.3	12.3	493	635	7.2	12.9	524	477	7.5	12.3	491	646	6.8	12.4	470	656	6.2	12.2	361	639	4.5	11.5	312	632	3.5	11.3	294	623	3.2	11.3	426	623	5.6	10.7
Briscoe	279	489	2.9	10.1	326	501	3.8	10.2	383	472	4.7	10.5	445	508	6.0	10.7	476	506	6.8	10.9	469	498	6.8	11.1	493	502	7.1	10.7	462	563	6.4	10.9	440	573	5.7	11.0	328	551	3.8	10.8	277	459	3.0	10.7	255	487	2.7	10.5	388	487	5.0	11.3
Brooks	263	548	2.8	11.1	306	393	3.5	10.9	343	563	4.3	11.2	400	533	5.2	11.5	439	479	6.0	11.8	447	392	6.3	11.6	464	424	6.5	11.4	443	503	5.9	11.6	407	373	5.2	11.1	330	621	3.9	11.2	270	538	3.0	11.0	238	502	2.6	11.1	363	502	4.6	11.0
Brown	268	547	2.9	11.0	320	485	3.8	10.9	364	383	4.6	11.0	413	477	5.6	11.0	446	557	6.5	11.4	445	550	6.5	11.5	469	395	6.9	11.4	457	471	6.3	10.1	426	538	5.5	10.5	302	560	3.7	11.3	264	557	2.9	11.3	242	507	2.6	10.0	367	507	4.8	11.1
Burleson	251	548	2.7	10.9	298	427	3.4	10.9	329	418	4.1	10.9	386	444	5.1	11.2	417	539	5.9	11.5	428	513	6.2	11.5	445	404	6.5	11.4	439	446	5.9	11.1	399	423	5.1	11.1	300	572	3.6	11.2	257	589	2.9	11.1	224	556	2.4	10.7	342	556	4.4	10.9
Burnet	253	558	2.8	10.9	301	410	3.5	10.8	329	419	4.1	10.8	382	437	5.1	10.9	417	552	6.0	11.1	431	549	6.3	11.3	453	359	6.7	10.9	454	464	6.1	10.5	405	439	5.2	10.8	292	584	3.5	11.1	256	608	2.8	11.1	225	570	2.4	10.3	348	570	4.5	10.9
Caldwell	247	565	2.7	11.0	296	392	3.4	10.7	318	428	4.0	10.8	373	419	4.9	10.9	409	551	5.9	11.0	428	550	6.3	11.2	447	355	6.6	10.7	453	467	6.0	10.8	399	411	5.1	11.0	288	593	3.4	11.1	254	632	2.8	11.1	220	608	2.4	10.6	343	608	4.4	11.3
Calhoun	252	532	2.8	11.1	295	447	3.4	11.0	329	474	4.1	11.0	389	521	5.1	11.5	417	519	5.9	11.7	428	439	6.2	11.6	442	411	6.4	11.5	428	447	5.8	11.3	403	393	5.2	11.2	314	603	3.8	11.3	263	574	3.0	11.3	233	531	2.5	11.1	347	531	4.5	11.2
Callahan	269	547	3.0	11.2	338	493	4.0	10.9	382	351	4.8	11.0	427	428	5.8	10.8	461	562	6.8	11.4	454	571	6.8	11.4	476	433	7.1	11.4	469	523	6.6	10.8	442	577	5.7	11.2	297	573	3.7	11.3	276	575	3.0	11.6	248	599	2.7	11.2	379	599	5.0	12.0
Cameron	257	651	2.9	11.2	283	575	3.3	11.6	360	659	4.4	11.7	389	563	5.1	12.5	414	402	5.9	13.6	472	330	6.3	12.5	482	606	6.4	12.4	448	384	5.9	12.6	428	244	5.3	11.7	382	423	4.4	11.3	278	349	3.2	11.4	243	292	2.7	11.0	369	292	4.6	12.3
Camp	229	509	2.5	10.9	281	400	3.3	11.4	295	378	3.8	12.6	353	383	4.8	12.5	382	436	5.5	13.5	375	468	5.5	12.8	408	477	6.1	14.2	397	375	5.6	13.4	368	556	4.8	12.7	282	491	3.4	11.8	231	560	2.6	11.4	197	531	2.1	11.0	313	531	4.1	10.6
Carson	279	483	2.9	10.1	324	507	3.8	10.1	381	480	4.7	10.3	445	513	6.0	10.6	474	501	6.8	10.7	466	491	6.8	10.9	493	519	7.1	10.4	461	573	6.3	10.8	439	580	5.7	10.8	326	557	3.8	10.8	274	452	3.0	10.7	254	491	2.6	10.6	386	491	5.0	12.2
Cass	236	513	2.6	10.8	285	411	3.3	11.3	304	385	3.9	12.4	364	391	4.9	12.3	392	454	5.6	13.3	389	471	5.7	12.7	415	465	6.2	13.9	405	385	5.7	13.1	375	533	4.8	12.5	290	490	3.5	11.7	237	557	2.7	11.3	203	527	2.2	10.9	320	527	4.2	10.6
Castro	280	485	2.9	10.1	326	512	3.8	10.1	384	485	4.7	10.4	447	518	6.0	10.6	477	503	6.9	10.7	468	492	6.8	11.0	496	521	7.1	10.5	461	577	6.3	10.9	442	588	5.7	10.9	328	562	3.8	10.8	276	453	3.0	10.7	256	492	2.7	10.6	389	492	5.0	11.0
Chambers	242	536	2.6	10.7	285	494	3.2	10.8	328	359	4.1	10.2	394	481	5.1	11.2	415	563	5.8	11.4	418	508	5.9	11.3	428	520	6.1	11.2	398	431	5.3	10.8	383	377	4.7	11.0	304	583	3.6	11.1	260	595	2.9	11.1	215	568	2.3	11.0	338	568	4.3	12.4
Cherokee	226	514	2.5	11.0	279	401	3.2	11.5	292	376	3.7	12.6	348	380	4.7	12.5	378	436	5.5	13.6	370	468	5.5	12.9	404	479	6.0	14.2	392	370	5.6	13.5	366	557	4.7	12.7	280	496	3.4	11.8	230	570	2.6	11.4	194	541	2.1	11.1	311	541	4.1	10.9
Childress	278	496	3.0	10.3	326	470	3.8	10.4	376	438	4.7	11.0	439	483	5.9	11.0	470	510	6.7	11.4	467	514	6.8	11.5	482	457	7.0	11.4	465	524	6.4	11.1	431	532	5.5	11.1	325	514	3.9	11.0	275	476	3.0	10.8	249	476	2.7	10.4	383	476	4.9	10.8
Clay	273	472	2.9	10.3	308	418	3.5	10.3	358	400	4.5	10.8	426	459	5.7	10.8	451	501	6.4	11.2	452	509	6.6	11.2	464	441	6.8	11.4	459	484	6.3	10.7	410	476	5.3	10.8	319	480	3.8	11.0	257	459	2.8	10.8	232	444	2.5	10.3	365	444	4.7	11.2
Cochran	287	510	3.1	10.3	343	488	4.0	10.5	402	479	5.0	11.4	457	511	6.2	11.5	497	525	6.9	11.8	487	518	7.0	11.8	504	441	7.2	11.7	472	535	6.5	11.6	447	552	5.7	11.6	345	527	4.1	11.1	294	472	3.2	10.8	269	466	2.9	10.5	407	466	5.2	11.2
Coke	277	537	3.1	10.6	334	489	3.9	10.7	387	403	4.8	11.5	435	487	5.9	11.5	476	551	6.7	11.9	472	541	6.8	11.9	492	394	7.1	12.0	465	486	6.4	11.0	439	544	5.6	11.3	325	548	4.0	11.2	283	523	3.1	11.0	257	479	2.8	10.0	391	479	5.0	10.9
Coleman	268	552	3.0	11.0	322	499	3.8	10.9	368	373	4.6	11.0	415	478	5.7	11.0	448	562	6.5	11.4	445	560	6.6	11.4	471	397	7.0	11.4	458	475	6.4	10.0	429	555	5.6	10.5	299	559	3.7	11.4	265	565	2.9	11.4	244	515	2.7	10.0	369	515	4.9	11.3
Collin	259	488	2.8	10.5	298	411	3.4	10.7	335	391	4.2	11.3	401	429	5.3	11.4	427	482	6.1	12.0	429	490	6.2	11.8	444	444	6.5	12.3	439	436	6.0	11.5	395	473	5.1	11.3	309	481	3.7	11.2	250	502	2.8	10.9	221	474	2.4	10.5	343	474	4.5	10.9
Collingsworth	278	489	2.9	10.2	324	469	3.7	10.3	374	447	4.7	10.9	441	487	5.9	10.9	469	503	6.6	11.3	467	507	6.8	11.4	482	466	7.0	11.3	465	529	6.4	11.0	430	531	5.5	11.0	325	507	3.9	10.9	273	465	3.0	10.7	249	469	2.6	10.4	382	469	4.9	11.2
Colorado	252	546	2.7	10.9	297	444	3.4	10.9	331	427	4.2	10.9	390	471	5.1	11.3	419	540	5.9	11.6	429	494	6.2	11.6	444	422	6.4	11.4	432	446	5.8	11.1	399	411	5.1	11.2	305	583	3.7	11.2	260	583	2.9	11.1	226	548	2.4	10.8	345	548	4.4	11.0
Comal	256	559	2.8	11.0	303	414	3.5	10.8	330	441	4.1	10.9	385	453	5.1	11.1	419	550	6.0	11.2	433	527	6.3	11.5	454	361	6.7	11.0	453	464	6.1	10.8	406	434	5.2	11.0	296	591	3.5	11.2	259	592	2.9	11.1	229	554	2.5	10.5	350	554	4.5	11.0
Comanche	267	539	2.9	10.9	318	467	3.7	10.8	360	391	4.5	11.0	412	467	5.6	11.0	445	549	6.4	11.4	445	541	6.5	11.5	467	400	6.9	11.4	457	474	6.3	10.5	422	519	5.4	10.8	305	559	3.7	11.3	265	550	2.9	11.3	241	512	2.6	10.3	365	512	4.8	10.5
Concho	264	567	2.9	10.9	299	526	3.5	10.9	348	375	4.4	10.8	394	545	5.4	11.1	426	567	6.2	11.2	426	565	6.3	11.3	461	357	6.8	11.3	441	406	6.1	8.3	413	544	5.3	9.1	291	538	3.6	11.4	243	578	2.7	11.4	234	420	2.6	8.2	353	420	4.7	10.9
Cooke	269	461	2.8	10.2	299	397	3.4	10.3	347	392	4.4	10.9	418	442	5.6	10.9	441	485	6.2	11.4	443	489	6.5	11.3	454	441	6.7	11.6	452	456	6.2	10.9	399	449	5.1	10.8	318	460	3.8	11.0	250	452	2.7	10.7	224	429	2.4	10.3	353	429	4.6	11.0
Coryell	258	547	2.8	10.9	305	429	3.5	10.8	338	410	4.3	11.0	393	445	5.2	11.1	426	549	6.1	11.3	435	535	6.4	11.5	456	374	6.7	11.3	451	456	6.1	10.7	408	462	5.3	11.0	300	567	3.6	11.2	259	580	2.9	11.1	230	540	2.5	10.4	352	540	4.6	11.0
Cottle	278	507	3.0	10.4	329	476	3.8	10.5	380	429	4.7	11.1	439	480	5.9	11.1	472	520	6.7	11.5	468	524	6.8	11.6	485	449	7.0	11.5	466	523	6.4	11.1	434	540	5.6	11.2	324	527	3.9	11.1	274	491	3.0	10.9	252	491	2.7	10.4	385	491	5.0	11.7
Crane	297	488	3.4	10.9	361	426	4.3	11.1	425	452	5.3	11.9	467	478	6.4	12.0	514	496	7.2	12.3	495	491	7.1	12.3	520	356	7.4	12.2	484	487	6.6	12.1	461	508	6.0	12.1	356	486	4.4	11.4	306	428	3.4	11.2	284	401	3.1	10.9	421	401	5.4	11.5
Crockett	295	568	3.3	10.7	351	543	4.1	11.0	403	521	5.0	11.6	446	570	6.1	11.9	483	587	6.8	12.2	471	548	6.8	12.5	506	396	7.3	12.2	477	547	6.5	11.6	452	561	5.8	11.6	336	577	4.1	11.5	294	502	3.2	11.2	275	449	3.0	10.4	405	449	5.2	11.1

	Jan				Feb				Mar				Apr				May				Jun				Jul				Aug				Sep				Oct				Nov				Dec				Annual			
County	α	β	γ	τ	α	β	γ	τ	α	β	γ	τ	α	β	γ	τ	α	β	γ	τ	α	β	γ	τ	α	β	γ	τ	α	β	γ	τ	α	β	γ	τ	α	β	γ	τ	α	β	γ	τ	α	β	γ	τ	α	β	γ	τ
Crosby	282	503	3.1	10.2	336	477	3.9	10.4	393	445	4.9	11.4	449	490	6.0	11.4	488	516	6.8	11.8	483	513	6.9	11.7	499	442	7.1	11.7	468	526	6.4	11.5	442	543	5.6	11.5	338	528	4.0	11.0	288	472	3.2	10.7	262	470	2.8	10.3	399	470	5.1	11.8
Culberson	303	607	3.5	11.2	373	589	4.4	11.3	442	603	5.6	12.0	480	619	6.6	12.1	533	625	7.5	12.3	505	608	7.3	12.4	522	452	7.4	12.4	493	612	6.8	12.2	469	636	6.2	12.2	369	595	4.6	11.3	311	610	3.5	11.3	293	605	3.2	11.2	429	605	5.6	10.8
Dallam	281	500	3.0	10.1	330	511	3.9	10.3	383	491	4.8	10.7	449	519	6.0	10.9	480	516	6.8	11.1	473	510	6.9	11.3	491	503	7.1	11.0	466	564	6.4	11.1	438	571	5.6	11.1	332	536	3.9	10.9	281	469	3.1	10.7	258	486	2.7	10.5	394	486	5.1	11.3
Dallas	258	502	2.8	10.6	300	420	3.4	10.8	336	391	4.2	11.4	399	430	5.3	11.4	426	492	6.1	12.0	429	497	6.2	11.8	446	437	6.6	12.3	439	436	6.0	11.5	398	477	5.1	11.4	307	498	3.7	11.3	253	522	2.8	11.0	223	492	2.4	10.5	344	492	4.5	11.5
Dawson	287	460	3.2	9.8	347	394	4.0	10.2	412	404	5.1	12.3	466	440	6.2	12.1	518	467	7.0	12.7	513	467	7.0	12.3	521	365	7.3	12.7	473	458	6.4	12.4	452	480	5.7	12.4	362	465	4.4	11.0	309	392	3.4	10.4	274	366	3.0	9.8	419	366	5.3	10.6
Deaf Smith	280	488	2.9	10.1	326	514	3.8	10.2	385	488	4.7	10.4	448	519	6.0	10.6	478	506	6.9	10.7	469	495	6.9	11.0	496	521	7.1	10.5	462	577	6.4	10.9	442	587	5.7	10.9	329	560	3.8	10.8	277	456	3.0	10.7	257	493	2.7	10.6	390	493	5.0	11.7
Delta	247	495	2.7	10.6	291	407	3.3	11.0	319	386	4.1	11.8	383	409	5.1	11.8	409	462	5.8	12.6	409	480	6.0	12.2	430	459	6.3	13.1	422	410	5.9	12.3	384	502	4.9	11.9	299	479	3.6	11.4	242	524	2.7	11.1	211	496	2.3	10.7	331	496	4.3	11.1
Denton	265	485	2.8	10.4	302	415	3.5	10.6	344	392	4.3	11.1	410	439	5.5	11.2	436	493	6.2	11.7	439	497	6.4	11.5	453	437	6.7	11.9	447	450	6.1	11.2	402	465	5.2	11.1	313	483	3.8	11.1	254	491	2.8	10.9	226	464	2.4	10.4	351	464	4.5	11.2
DeWitt	255	540	2.8	11.1	299	432	3.5	10.9	330	466	4.2	11.0	388	498	5.1	11.4	419	533	6.0	11.6	430	467	6.2	11.6	447	385	6.5	11.4	438	454	5.9	11.1	405	414	5.2	11.2	308	604	3.7	11.2	262	581	2.9	11.2	233	540	2.5	10.9	348	540	4.5	11.1
Dickens	280	511	3.0	10.4	334	479	3.9	10.5	388	430	4.8	11.3	444	481	6.0	11.3	481	524	6.8	11.7	476	525	6.8	11.7	493	439	7.1	11.7	467	522	6.4	11.3	440	544	5.6	11.4	331	532	4.0	11.1	284	491	3.1	10.9	258	488	2.8	10.4	393	488	5.1	11.9
Dimmit	306	544	3.2	11.0	351	441	3.9	10.9	377	591	4.7	11.9	433	558	5.7	12.3	462	596	6.3	12.5	473	366	6.6	13.5	484	315	7.0	13.0	470	454	6.4	12.3	428	550	5.6	12.1	335	635	4.0	11.3	293	352	3.2	10.9	274	314	2.9	10.7	396	314	5.0	10.7
Donley	279	489	2.9	10.2	325	491	3.8	10.2	379	465	4.7	10.6	444	502	6.0	10.8	473	504	6.7	11.0	468	500	6.8	11.2	489	491	7.0	10.9	463	552	6.4	10.9	436	559	5.6	11.0	327	536	3.8	10.9	275	461	3.0	10.7	253	481	2.7	10.5	386	481	5.0	11.5
Duval	275	524	2.9	11.2	318	407	3.6	11.0	347	552	4.3	11.5	407	546	5.3	11.8	437	532	6.1	12.0	450	365	6.4	12.3	459	349	6.6	12.0	444	446	6.0	11.8	411	449	5.3	11.6	327	635	3.9	11.2	276	477	3.1	11.1	252	442	2.7	11.1	368	442	4.7	11.1
Eastland	269	538	3.0	10.9	327	479	3.8	10.8	371	374	4.7	11.0	421	452	5.7	11.0	454	548	6.6	11.4	451	554	6.6	11.4	472	420	7.0	11.4	462	497	6.4	10.7	431	541	5.6	10.9	304	556	3.7	11.3	270	556	3.0	11.3	245	545	2.7	10.6	371	545	4.9	11.7
Ector	294	426	3.3	10.6	357	339	4.2	10.9	422	380	5.3	12.1	467	406	6.3	12.0	517	427	7.2	12.4	501	431	7.1	12.3	520	324	7.4	12.4	481	422	6.6	12.2	458	443	5.9	12.2	359	424	4.4	11.3	307	338	3.4	11.0	282	307	3.1	10.6	421	307	5.4	11.4
Edwards	293	581	3.2	10.6	336	556	3.9	11.0	372	509	4.7	11.4	420	584	5.8	11.8	448	594	6.3	12.2	440	512	6.4	12.8	485	404	7.0	12.5	471	520	6.3	10.9	440	517	5.5	11.0	315	586	3.8	11.6	278	426	3.0	11.2	264	320	2.8	9.7	386	320	4.9	11.7
El Paso	319	617	3.6	9.4	386	617	4.5	9.9	466	611	5.7	12.8	512	628	6.9	12.4	573	631	7.5	13.2	564	596	7.6	12.6	512	598	7.1	13.3	491	570	6.7	13.1	478	593	5.9	13.0	373	574	4.7	10.9	317	573	3.6	10.0	285	627	3.1	9.4	447	627	5.6	11.4
Ellis	256	514	2.8	10.7	301	422	3.5	10.9	335	396	4.2	11.5	395	430	5.3	11.5	424	503	6.0	12.1	427	495	6.2	11.9	445	423	6.5	12.3	437	429	6.0	11.6	399	479	5.1	11.5	305	514	3.7	11.3	254	535	2.8	11.1	224	501	2.4	10.5	344	501	4.5	11.0
Erath	267	529	2.9	10.8	316	457	3.7	10.7	357	393	4.5	11.0	412	462	5.5	11.1	444	536	6.4	11.5	445	536	6.5	11.5	465	411	6.8	11.5	455	476	6.3	10.7	419	504	5.4	10.9	307	544	3.7	11.2	265	545	2.9	11.2	239	513	2.6	10.3	362	513	4.7	11.2
Falls	254	542	2.8	10.9	301	419	3.5	10.8	332	411	4.2	11.1	389	435	5.2	11.2	420	533	6.0	11.5	429	516	6.3	11.6	448	395	6.6	11.5	443	446	6.0	11.1	401	445	5.2	11.2	300	562	3.6	11.2	257	580	2.8	11.1	225	546	2.4	10.6	345	546	4.5	11.3
Fannin	257	480	2.7	10.4	294	403	3.3	10.7	331	391	4.2	11.4	399	424	5.3	11.4	423	472	6.0	12.1	425	483	6.2	11.8	440	451	6.5	12.4	436	430	6.0	11.7	390	474	5.0	11.4	308	468	3.7	11.2	246	492	2.7	10.9	217	466	2.3	10.5	341	466	4.4	11.1
Fayette	251	554	2.7	11.0	298	421	3.4	10.8	327	430	4.1	10.9	384	448	5.1	11.2	416	544	5.9	11.4	429	517	6.3	11.5	447	388	6.5	11.2	443	455	6.0	11.0	400	416	5.1	11.1	298	586	3.6	11.2	258	601	2.9	11.1	225	570	2.4	10.7	345	570	4.5	11.3
Fisher	275	535	3.0	10.7	338	485	4.0	10.7	388	383	4.9	11.4	437	451	5.9	11.2	476	549	6.8	11.8	470	551	6.8	11.7	488	422	7.1	11.8	469	515	6.5	11.2	442	560	5.7	11.5	318	555	3.9	11.2	284	537	3.1	11.2	255	542	2.8	10.7	390	542	5.1	10.9
Floyd	281	496	3.0	10.2	331	492	3.9	10.3	387	461	4.8	10.9	446	501	6.0	11.0	481	512	6.8	11.3	474	506	6.8	11.4	495	475	7.1	11.1	465	548	6.4	11.1	440	560	5.7	11.2	332	541	3.9	10.9	282	467	3.1	10.8	258	480	2.7	10.4	392	480	5.0	11.0
Foard	276	509	3.0	10.5	327	468	3.8	10.5	375	412	4.7	11.1	435	469	5.9	11.1	466	524	6.6	11.5	464	529	6.7	11.5	479	441	7.0	11.6	465	513	6.4	11.0	431	531	5.5	11.1	320	522	3.9	11.1	274	499	3.0	11.0	248	497	2.7	10.5	381	497	4.9	11.0
Fort Bend	245	534	2.7	10.8	289	476	3.2	10.8	330	379	4.1	10.3	393	488	5.2	11.2	417	551	5.8	11.4	420	500	6.0	11.3	434	501	6.2	11.1	408	438	5.4	10.8	388	387	4.8	10.9	303	590	3.6	11.1	260	584	2.9	11.1	219	556	2.4	10.9	339	556	4.3	12.1
Franklin	236	506	2.6	10.8	285	404	3.3	11.2	304	382	3.9	12.3	364	393	4.9	12.3	392	447	5.6	13.2	388	472	5.7	12.6	416	470	6.2	13.8	406	387	5.7	13.0	374	537	4.8	12.4	289	488	3.5	11.7	236	549	2.7	11.3	202	520	2.2	10.9	319	520	4.2	11.7
Freestone	246	525	2.7	10.8	294	423	3.4	11.1	321	397	4.1	11.7	380	421	5.1	11.8	409	495	5.8	12.5	411	490	6.0	12.2	433	439	6.4	12.8	423	416	5.8	12.1	389	488	5.0	11.8	298	525	3.6	11.5	249	565	2.8	11.2	216	532	2.3	10.8	333	532	4.3	11.5
Frio	285	546	3.0	11.0	330	449	3.7	10.9	361	532	4.5	11.5	416	540	5.5	11.8	446	567	6.2	12.1	454	421	6.5	12.6	472	350	6.8	12.2	459	461	6.2	11.6	422	495	5.4	11.5	323	614	3.9	11.3	279	447	3.1	11.1	257	398	2.7	10.6	378	398	4.8	11.5
Gaines	290	480	3.2	10.4	351	421	4.1	10.6	413	437	5.2	11.9	463	467	6.3	11.9	511	488	7.0	12.3	499	485	7.0	12.2	514	375	7.3	12.3	477	482	6.5	12.1	453	502	5.8	12.1	356	482	4.3	11.1	303	421	3.3	10.8	276	398	3.0	10.4	417	398	5.3	10.9
Galveston	241	532	2.6	10.7	284	491	3.1	10.7	328	353	4.1	10.0	394	493	5.1	11.1	415	562	5.8	11.2	416	510	5.9	11.2	428	534	6.1	11.0	396	436	5.3	10.6	382	374	4.7	10.8	301	596	3.6	11.1	259	593	2.9	11.0	214	570	2.3	11.0	337	570	4.3	11.3
Garza	283	503	3.1	10.1	341	462	4.0	10.3	400	429	5.0	11.8	454	478	6.1	11.7	500	514	6.9	12.2	495	513	6.9	12.0	507	415	7.2	12.3	470	506	6.4	11.9	446	527	5.6	12.0	347	517	4.2	11.0	297	467	3.2	10.6	266	455	2.9	10.0	407	455	5.2	10.9
Gillespie	265	563	2.9	10.9	307	473	3.6	10.9	345	427	4.3	11.0	396	507	5.3	11.2	428	560	6.1	11.4	434	532	6.4	11.6	461	364	6.8	11.4	450	445	6.1	9.9	413	488	5.3	10.3	300	571	3.6	11.3	257	562	2.8	11.2	237	470	2.6	9.5	356	470	4.6	11.6
Glasscock	288	457	3.2	9.6	348	383	4.0	10.1	417	395	5.2	12.6	471	435	6.2	12.3	528	463	7.0	13.0	526	458	7.1	12.5	529	346	7.4	13.1	473	442	6.3	12.8	454	469	5.6	12.8	371	461	4.5	10.9	315	381	3.4	10.1	277	345	3.1	9.6	425	345	5.3	11.3
Goliad	252	519	2.8	11.2	294	430	3.4	11.0	324	479	4.1	11.1	385	531	5.1	11.4	413	518	5.9	11.6	423	431	6.2	11.5	439	382	6.4	11.4	428	449	5.8	11.2	404	398	5.2	11.2	310	622	3.8	11.3	262	586	3.0	11.4	235	541	2.6	11.2	345	541	4.5	11.1
Gonzales	254	554	2.8	11.0	300	419	3.4	10.8	328	449	4.1	11.0	384	462	5.1	11.2	417	544	6.0	11.3	431	507	6.3	11.5	449	374	6.6	11.1	446	460	6.0	11.0	403	419	5.2	11.1	300	596	3.6	11.2	259	598	2.9	11.1	228	563	2.5	10.7	347	563	4.5	10.7
Gray	279	487	2.9	10.1	325	489	3.8	10.2	377	467	4.7	10.6	444	502	6.0	10.8	472	501	6.7	11.0	467	499	6.8	11.2	488	493	7.0	10.9	463	552	6.4	10.9	435	555	5.6	10.9	326	530	3.8	10.9	275	458	3.0	10.7	252	479	2.6	10.5	385	479	4.9	11.0
Grayson	264	466	2.8	10.2	296	397	3.3	10.4	340	393	4.1	11.1	411	435	5.5	11.1	434	479	6.1	11.6	437	486	6.4	11.5	448	445	6.6	11.9	446	446	6.1	11.2	395	455	5.1	11.0	315	460	3.8	11.0	247	464	2.7	10.8	221	440	2.4	10.3	348	440	4.5	12.6
Gregg	219	509	2.4	11.0	275	388	3.2	11.6	282	370	3.6	12.9	337	370	4.6	12.7	367	416	5.4	13.9	356	463	5.3	13.1	396	489	5.9	14.7	384	359	5.5	13.8	359	583	4.7	13.0	272	491	3.3	11.9	223	570	2.6	11.5	187	542	2.0	11.2	304	542	4.0	11.3
Grimes	249	540	2.7	10.9	294	452	3.4	10.9	329	402	4.1	10.9	389	454	5.1	11.4	417	534	5.9	11.8	423	496	6.1	11.7	438	448	6.4	11.7	424	431	5.7	11.3	393	425	5.0	11.3	304	562	3.6	11.3	257	577	2.9	11.2	222	543	2.4	10.8	340	543	4.4	11.0
Guadalupe	254	558	2.8	11.0	301	412	3.5	10.8	328	445	4.1	10.9	383	452	5.0	11.1	417	548	6.0	11.2	432	520	6.3	11.4	451	363	6.6	11.0	451	463	6.1	10.9	404	424	5.2	11.1	297	595	3.6	11.1	259	599	2.9	11.1	228	566	2.5	10.6	348	566	4.5	10.8
Hale	281	493	3.0	10.1	331	500	3.9	10.3	388	474	4.8	10.8	448	510	6.0	11.0	482	509	6.8	11.2	474	501	6.9	11.3	497	490	7.1	11.0	465	557	6.4	11.1	442	570	5.7	11.2	333	545	3.9	10.9	282	459	3.1	10.7	259	480	2.7	10.5	394	480	5.1	10.9
Hall	279	495	3.0	10.2	327	484	3.8	10.3	380	453	4.7	10.8	443	494	5.9	10.9	474	510	6.7	11.2	469	508	6.8	11.3	488	473	7.0	11.1	464	541	6.4	11.0	436	550	5.6	11.1	327	530	3.9	10.9	277	470	3.0	10.8	253	480	2.7	10.4	387	480	5.0	11.0
Hamilton	263	539	2.9	10.8	311	446	3.6	10.8	349	405	4.4	11.0	403	463	5.4	11.1	435	545	6.2	11.4	440	532	6.4	11.5	461	388	6.8	11.4	453	462	6.2	10.6	414	489	5.3	10.8	304	559	3.7	11.2	262	557	2.9	11.2	235	513	2.5	10.2	358	513	4.7	10.7
Hansford	280	491	2.9	10.1	326	494	3.8	10.2	377	476	4.7	10.7	445	508	6.0	10.8	473	505	6.7	11.0	469	502	6.8	11.2	487	494	7.0	10.9	464	555	6.4	11.0	435	554	5.6	11.0	327	526	3.8	10.8	276	461	3.0	10.7	253	479	2.6	10.4	387	479	5.0	11.0
Hardeman	277	498	3.0	10.4	324	461	3.7	10.5	372	421	4.7	11.0	436	474	5.8	11.0	465	515	6.6	11.5	464	521	6.7	11.5	478	447	7.0	11.5	465	513	6.4	11.0	428	521	5.5	11.1	322	510	3.9	11.0	272	484	3.0	10.9	246	480	2.6	10.4	379	480	4.9	11.6
Hardin	248	561	2.7	10.8	289	511	3.3	11.1	327	388	4.2	11.3	394	415	5.1	11.8	413	563	5.8	12.4	430	494	6.0	12.0	425	438	6.2	12.5	410	403	5.6	12.0	386	397	4.9	11.7	320	514	3.8	11.4	262	602	3.0	11.2	221	559	2.4	11.0	341	559	4.4	10.9
Harris	242	531	2.6	10.7	286	483	3.2	10.8	328	361	4.1	10.1	393	491	5.1	11.1	416	557	5.8	11.3	416	507	5.9	11.2	430	525	6.1	11.0	400	437	5.3	10.6	384	381	4.7	10.9	300	595	3.6	11.1	259	590	2.9	11.1	215	565	2.3	11.0	337	565	4.3	12.4
Harrison	228	514	2.5	10.9	280	403	3.3	11.4	294	378	3.8	12.6	351	379	4.7	12.5	380	438	5.5	13.6	374	467	5.5	12.9	406	475	6.0	14.3	395	371	5.6	13.4	367	553	4.8	12.7	282	491	3.4	11.8	231	568	2.7	11.4	196	538	2.1	11.1	312	538	4.1	10.7
Hartley	281	495	2.9	10.1	328	513	3.9	10.2	384	490	4.7	10.6	449	519	6.0	10.8	479	512	6.8	10.9	471	504	6.9	11.2	493	511	7.1	10.8	464	570	6.4	11.0	440	578	5.7	11.0	331	547	3.9	10.8	279	463	3.0	10.7	258	489	2.7	10.5	392	489	5.0	11.2
Haskell	272	534	3.0	10.9	335	483	4.0	10.8	382	373	4.8	11.1	431	440	5.9	10.9	465	550	6.7	11.5	459	555	6.8	11.5	479	430	7.1	11.5	468	518	6.5	11.0	439	563	5.7	11.2	307	557	3.8	11.3	277	546	3.0	11.3	250	561	2.7	11.0	381	561	5.0	10.9
Hays	247	566	2.7	11.0	296	387	3.4	10.7	317	424	4.0	10.8	372	413	4.9	10.8	408	552	5.9	10.9	427	558	6.3	11.2	448	349	6.6	10.6	455	469	6.1	10.7	399	412	5.1	11.0	286	592	3.4	11.1	253	634	2.8	11.0	219	611	2.4	10.6	343	611	4.4	10.8
Hemphill	278	482	2.9	10.1	322	463	3.7	10.3	368	456	4.6	10.9	442	489	5.9	11.0	466	493	6.6	11.3	467	501	6.8	11.4	478	473	6.9	11.4	466	528	6.4	11.0	427	519	5.5	11.0	323	487	3.8	10.9	271	457	2.9	10.6	246	460	2.6	10.3	380	460	4.9	12.1

	Jan				Feb				Mar				Apr				May				Jun				Jul				Aug				Sep				Oct				Nov				Dec				Annual			
County	α	β	γ	τ	α	β	γ	τ	α	β	γ	τ	α	β	γ	τ	α	β	γ	τ	α	β	γ	τ	α	β	γ	τ	α	β	γ	τ	α	β	γ	τ	α	β	γ	τ	α	β	γ	τ	α	β	γ	τ	α	β	γ	τ
Henderson	236	513	2.6	10.9	286	407	3.3	11.3	306	384	3.9	12.3	365	397	4.9	12.2	394	458	5.7	13.1	390	476	5.7	12.6	418	461	6.2	13.6	408	390	5.7	12.9	377	530	4.9	12.3	289	502	3.5	11.7	238	559	2.7	11.3	205	528	2.2	10.9	321	528	4.2	10.9
Hidalgo	257	559	2.8	11.0	304	332	3.5	10.8	343	575	4.2	10.8	400	513	5.2	10.9	452	438	6.0	11.3	447	421	6.2	11.0	473	465	6.5	10.6	446	589	5.8	11.2	398	326	5.1	10.6	328	645	3.9	11.0	265	611	2.9	10.8	225	582	2.4	11.0	361	582	4.5	11.3
Hill	258	524	2.8	10.7	304	426	3.5	10.8	339	400	4.3	11.3	398	438	5.3	11.4	428	520	6.1	11.8	433	506	6.3	11.8	451	406	6.6	12.0	443	439	6.1	11.3	404	469	5.2	11.3	305	531	3.7	11.3	258	546	2.9	11.1	228	510	2.5	10.5	348	510	4.5	11.2
Hockley	285	500	3.1	10.2	340	479	4.0	10.4	398	466	5.0	11.4	454	501	6.1	11.4	495	515	6.9	11.7	486	509	6.9	11.7	503	442	7.2	11.7	470	529	6.4	11.6	446	546	5.7	11.6	343	525	4.1	11.0	292	460	3.2	10.8	266	457	2.9	10.4	405	457	5.2	11.0
Hood	265	519	2.9	10.7	312	443	3.6	10.7	352	394	4.4	11.0	410	453	5.5	11.1	440	523	6.3	11.5	443	524	6.5	11.5	461	418	6.8	11.6	452	467	6.2	10.8	414	487	5.3	11.0	309	529	3.7	11.2	262	534	2.9	11.1	235	503	2.5	10.3	358	503	4.6	12.0
Hopkins	240	503	2.6	10.7	287	406	3.3	11.1	310	383	4.0	12.1	372	399	5.0	12.1	399	453	5.7	13.0	396	476	5.8	12.4	422	465	6.2	13.5	413	397	5.8	12.7	379	523	4.9	12.2	293	486	3.5	11.6	239	541	2.7	11.2	206	512	2.2	10.8	324	512	4.2	11.9
Houston	240	527	2.6	10.9	288	431	3.3	11.2	313	390	4.0	11.9	373	412	5.0	12.0	400	487	5.7	12.7	402	481	5.8	12.3	423	458	6.2	13.1	410	398	5.7	12.4	382	490	4.9	12.0	296	519	3.6	11.6	245	572	2.8	11.3	210	539	2.3	11.0	326	539	4.3	11.6
Howard	287	469	3.1	9.3	349	401	4.0	9.9	420	400	5.2	12.8	475	444	6.2	12.4	536	478	7.0	13.2	535	472	7.1	12.5	534	360	7.4	13.3	473	455	6.3	13.0	455	485	5.6	13.0	378	476	4.5	10.9	320	402	3.5	10.0	278	372	3.1	9.4	428	372	5.3	11.7
Hudspeth	310	605	3.5	10.3	376	598	4.4	10.6	447	599	5.6	12.3	489	615	6.6	12.3	543	623	7.4	12.7	526	598	7.4	12.6	514	526	7.2	12.8	489	589	6.7	12.6	469	612	6.0	12.5	368	584	4.6	11.1	312	582	3.5	10.6	288	600	3.1	10.4	435	600	5.6	11.6
Hunt	250	497	2.7	10.6	293	410	3.4	10.9	323	387	4.1	11.7	387	414	5.2	11.7	414	469	5.9	12.5	414	484	6.0	12.1	434	454	6.4	12.9	426	416	5.9	12.1	388	495	5.0	11.7	301	484	3.6	11.4	245	524	2.7	11.1	214	495	2.3	10.6	334	495	4.3	10.6
Hutchinson	279	487	2.9	10.1	325	501	3.8	10.2	379	478	4.7	10.5	445	511	6.0	10.7	474	503	6.8	10.9	468	497	6.8	11.1	490	507	7.0	10.7	463	564	6.4	10.9	437	568	5.6	10.9	327	542	3.8	10.8	275	456	3.0	10.7	254	485	2.6	10.5	387	485	5.0	11.3
Irion	284	539	3.1	10.5	337	495	3.9	10.7	391	447	4.9	11.7	439	522	5.9	11.8	481	551	6.7	12.1	475	528	6.8	12.1	498	379	7.2	12.2	467	488	6.4	11.2	441	534	5.6	11.4	334	543	4.1	11.3	287	493	3.1	11.0	264	427	2.9	9.8	397	427	5.1	11.0
Jack	270	500	2.9	10.5	314	440	3.6	10.6	360	394	4.5	10.9	421	458	5.6	11.0	450	515	6.4	11.4	450	521	6.6	11.4	465	432	6.8	11.5	458	483	6.3	10.8	416	494	5.4	10.9	314	512	3.8	11.1	263	502	2.9	11.0	237	484	2.5	10.4	364	484	4.7	11.2
Jackson	253	541	2.8	11.0	297	451	3.4	10.9	332	453	4.2	11.0	391	498	5.2	11.4	419	533	5.9	11.7	430	467	6.2	11.6	444	419	6.4	11.5	430	447	5.8	11.2	402	405	5.1	11.2	311	594	3.7	11.2	263	576	2.9	11.2	231	537	2.5	10.9	347	537	4.5	12.0
Jasper	250	576	2.7	10.9	290	525	3.3	11.3	324	400	4.2	12.0	393	367	5.1	12.2	410	563	5.8	13.0	436	488	6.0	12.5	421	392	6.2	13.4	414	381	5.7	12.8	386	408	5.0	12.3	329	463	3.9	11.6	263	614	3.0	11.3	223	563	2.5	11.0	342	563	4.4	11.9
Jeff Davis	307	615	3.6	11.4	377	606	4.5	11.4	447	616	5.7	12.1	478	633	6.6	12.2	531	637	7.5	12.3	502	622	7.3	12.8	524	469	7.5	12.5	494	628	6.9	12.3	471	649	6.2	12.2	372	611	4.6	11.4	314	625	3.5	11.3	295	620	3.3	11.3	430	620	5.6	11.7
Jefferson	250	572	2.7	10.9	289	530	3.3	11.1	328	390	4.2	11.4	397	401	5.2	11.9	414	578	5.8	12.5	437	495	6.0	12.1	424	422	6.1	12.7	411	398	5.6	12.1	387	383	4.9	11.8	327	499	3.9	11.5	265	612	3.0	11.3	223	565	2.4	11.0	344	565	4.4	11.5
Jim Hogg	281	542	2.9	11.1	325	388	3.7	10.9	357	586	4.4	11.5	415	537	5.4	11.8	451	519	6.1	12.1	463	359	6.4	12.4	472	371	6.7	12.0	453	475	6.1	12.0	412	441	5.3	11.5	336	632	4.0	11.1	280	459	3.1	10.9	252	430	2.7	11.0	376	430	4.7	11.3
Jim Wells	251	505	2.8	11.2	292	416	3.4	11.0	321	503	4.1	11.2	384	556	5.0	11.5	412	504	5.9	11.6	421	394	6.1	11.5	436	374	6.4	11.4	423	451	5.8	11.3	404	387	5.2	11.2	314	640	3.8	11.3	263	581	3.0	11.4	237	535	2.6	11.4	346	535	4.5	11.2
Johnson	262	516	2.8	10.7	307	431	3.5	10.7	345	394	4.3	11.2	404	441	5.4	11.3	434	515	6.2	11.7	437	510	6.4	11.7	455	416	6.7	11.9	447	448	6.1	11.1	407	473	5.2	11.1	308	520	3.7	11.2	259	533	2.9	11.0	231	499	2.5	10.4	351	499	4.6	11.2
Jones	270	545	3.0	11.2	341	493	4.1	10.9	386	349	4.9	11.1	430	421	5.9	10.8	465	561	6.8	11.4	457	572	6.8	11.4	478	437	7.1	11.4	471	529	6.6	11.0	445	581	5.8	11.3	299	573	3.7	11.3	278	573	3.1	11.5	250	608	2.7	11.4	381	608	5.0	11.3
Karnes	258	534	2.8	11.1	302	431	3.5	10.9	332	481	4.2	11.1	391	515	5.2	11.4	421	531	6.0	11.6	431	448	6.3	11.7	448	376	6.5	11.4	438	453	5.9	11.2	407	419	5.2	11.2	310	614	3.8	11.3	264	567	3.0	11.3	237	524	2.6	11.0	351	524	4.5	11.7
Kaufman	249	508	2.7	10.7	294	414	3.4	11.0	323	390	4.1	11.8	385	415	5.1	11.8	412	479	5.9	12.5	413	485	6.0	12.2	434	443	6.4	12.9	425	412	5.9	12.1	389	498	5.0	11.8	300	500	3.6	11.4	247	537	2.8	11.1	216	505	2.3	10.7	334	505	4.4	11.0
Kendall	264	559	2.9	10.9	309	446	3.6	10.9	342	447	4.3	11.0	395	487	5.3	11.3	428	554	6.1	11.4	437	515	6.4	11.7	460	367	6.7	11.4	453	458	6.1	10.6	412	462	5.3	10.8	303	584	3.6	11.3	261	559	2.9	11.2	236	498	2.6	10.1	357	498	4.6	11.4
Kenedy	256	558	2.8	11.2	296	432	3.4	11.1	339	560	4.2	11.2	392	542	5.1	11.6	427	465	6.0	12.0	443	390	6.2	11.6	460	456	6.4	11.5	437	475	5.9	11.6	409	342	5.2	11.2	334	587	4.0	11.2	268	529	3.0	11.2	236	486	2.6	11.1	357	486	4.5	11.3
Kent	280	517	3.1	10.4	338	475	3.9	10.5	392	416	4.9	11.6	445	473	6.0	11.5	486	531	6.8	12.0	481	529	6.8	11.9	496	421	7.1	12.0	469	512	6.4	11.5	442	542	5.6	11.6	333	534	4.0	11.1	289	498	3.2	10.8	260	491	2.8	10.3	398	491	5.1	10.9
Kerr	272	566	3.0	10.9	312	499	3.6	10.9	352	443	4.4	11.0	402	537	5.4	11.4	433	568	6.2	11.6	436	523	6.4	11.8	466	367	6.8	11.6	452	449	6.2	9.8	418	504	5.4	10.2	304	570	3.7	11.4	260	531	2.8	11.3	243	423	2.6	9.3	363	423	4.7	10.5
Kimble	265	573	2.9	10.9	297	529	3.5	11.0	344	393	4.3	10.8	390	560	5.3	11.2	421	572	6.1	11.3	422	558	6.2	11.4	459	352	6.8	11.3	440	404	6.1	8.3	411	534	5.3	9.0	291	544	3.6	11.5	242	570	2.7	11.4	235	400	2.6	8.0	352	400	4.6	11.1
King	277	518	3.0	10.6	332	478	3.9	10.6	382	410	4.8	11.2	438	469	5.9	11.2	473	532	6.7	11.6	468	536	6.8	11.6	485	437	7.1	11.7	467	518	6.4	11.2	437	546	5.6	11.3	322	536	3.9	11.1	280	511	3.1	11.0	253	511	2.7	10.5	386	511	5.0	11.8
Kinney	310	590	3.4	10.3	355	585	4.0	10.9	381	571	4.7	11.6	430	608	6.0	12.2	453	612	6.2	12.7	440	479	6.4	13.8	496	435	7.1	13.4	488	577	6.3	12.1	456	498	5.6	11.9	322	608	3.8	11.8	295	313	3.1	11.1	280	220	2.9	10.3	401	220	5.0	11.3
Kleberg	248	508	2.7	11.2	288	422	3.4	11.0	319	503	4.0	11.1	381	556	5.0	11.5	409	494	5.9	11.6	420	396	6.1	11.4	435	390	6.3	11.3	421	453	5.8	11.3	403	371	5.2	11.1	314	633	3.8	11.3	262	588	3.0	11.4	235	542	2.6	11.4	344	542	4.5	11.1
Knox	275	520	3.0	10.7	330	473	3.9	10.7	378	397	4.7	11.1	433	458	5.9	11.0	466	535	6.7	11.5	462	539	6.7	11.6	480	432	7.0	11.6	466	512	6.4	11.0	434	543	5.6	11.2	316	536	3.8	11.2	275	518	3.0	11.1	249	519	2.7	10.6	381	519	5.0	11.8
La Salle	297	533	3.1	11.1	342	414	3.8	10.9	368	578	4.6	11.8	426	546	5.6	12.2	455	579	6.3	12.3	470	353	6.6	13.2	476	308	6.9	12.7	462	434	6.3	12.2	420	529	5.5	11.9	333	638	4.0	11.2	288	385	3.1	10.9	267	352	2.8	10.8	387	352	4.9	11.6
Lamar	251	489	2.7	10.5	292	405	3.3	10.8	323	389	4.1	11.7	390	414	5.2	11.7	415	464	5.9	12.4	415	480	6.1	12.1	433	457	6.4	12.9	428	417	5.9	12.1	386	490	5.0	11.7	303	471	3.6	11.4	244	511	2.7	11.0	213	483	2.3	10.6	334	483	4.3	10.9
Lamb	283	497	3.0	10.2	333	500	3.9	10.3	391	479	4.8	10.9	451	513	6.1	11.0	485	512	6.9	11.2	477	504	6.9	11.4	499	484	7.1	11.1	466	555	6.4	11.2	443	569	5.7	11.2	335	542	4.0	10.9	284	461	3.1	10.7	261	478	2.8	10.5	397	478	5.1	10.9
Lampasas	259	550	2.8	10.9	306	433	3.5	10.8	340	412	4.3	10.9	394	460	5.3	11.0	427	551	6.1	11.2	436	540	6.4	11.4	458	371	6.7	11.1	452	461	6.1	10.4	410	468	5.3	10.7	299	574	3.6	11.2	259	581	2.8	11.1	232	531	2.5	10.2	353	531	4.6	11.2
Lavaca	253	549	2.8	11.0	299	436	3.4	10.9	330	447	4.2	11.0	388	476	5.1	11.3	419	540	6.0	11.5	430	491	6.2	11.6	447	397	6.5	11.3	438	453	5.9	11.1	402	415	5.2	11.2	305	593	3.7	11.2	261	588	2.9	11.2	229	552	2.5	10.8	347	552	4.5	11.0
Lee	250	556	2.7	11.0	297	407	3.4	10.8	324	422	4.1	10.9	380	430	5.0	11.1	414	545	5.9	11.2	428	532	6.3	11.4	447	378	6.6	11.0	447	457	6.0	10.9	400	415	5.1	11.1	294	582	3.5	11.1	256	609	2.8	11.1	222	581	2.4	10.7	344	581	4.4	11.6
Leon	247	531	2.7	10.9	294	432	3.4	11.0	323	399	4.1	11.5	382	427	5.1	11.7	410	506	5.8	12.3	414	491	6.0	12.0	434	440	6.3	12.5	422	418	5.8	11.9	390	470	5.0	11.7	300	536	3.6	11.4	251	570	2.8	11.2	217	536	2.4	10.8	334	536	4.3	11.1
Liberty	244	540	2.7	10.8	287	490	3.2	10.9	328	370	4.1	10.5	393	466	5.1	11.4	415	556	5.8	11.6	420	502	5.9	11.5	429	497	6.1	11.5	404	425	5.4	11.1	385	390	4.8	11.2	306	567	3.7	11.2	259	592	2.9	11.1	217	561	2.3	11.0	338	561	4.3	11.4
Limestone	252	531	2.7	10.8	299	426	3.4	10.9	330	404	4.2	11.4	389	433	5.2	11.5	418	517	6.0	12.0	424	502	6.2	11.9	443	417	6.5	12.1	434	433	5.9	11.5	398	465	5.1	11.5	302	541	3.6	11.3	255	567	2.8	11.1	223	533	2.4	10.6	341	533	4.4	10.9
Lipscomb	278	482	2.9	10.1	322	460	3.7	10.3	365	458	4.6	10.9	442	488	5.9	11.0	465	488	6.6	11.4	468	500	6.8	11.5	475	472	6.9	11.5	467	526	6.4	11.1	426	511	5.4	11.0	322	475	3.8	10.9	271	457	2.9	10.6	245	458	2.6	10.2	379	458	4.9	11.3
Live Oak	256	512	2.8	11.2	298	423	3.5	11.0	327	498	4.1	11.2	389	546	5.1	11.5	417	519	6.0	11.7	427	407	6.2	11.7	442	367	6.5	11.5	429	448	5.9	11.3	406	409	5.3	11.2	313	633	3.8	11.3	265	564	3.0	11.4	240	518	2.6	11.2	350	518	4.5	10.9
Llano	261	559	2.8	10.9	305	455	3.5	10.8	341	416	4.3	10.9	393	484	5.3	11.1	426	557	6.1	11.3	434	541	6.4	11.5	459	364	6.8	11.2	451	450	6.1	10.0	411	479	5.3	10.4	298	572	3.6	11.3	256	579	2.8	11.2	233	503	2.5	9.7	354	503	4.6	11.9
Loving	299	605	3.5	11.6	372	574	4.4	11.7	444	600	5.6	12.0	483	617	6.7	12.0	538	620	7.7	12.1	501	608	7.4	12.1	529	401	7.6	12.1	496	614	6.9	12.0	472	640	6.3	12.0	370	588	4.6	11.4	312	619	3.5	11.7	296	608	3.2	11.6	429	608	5.6	11.1
Lubbock	284	498	3.1	10.2	337	477	3.9	10.4	396	456	4.9	11.4	452	496	6.1	11.4	492	513	6.9	11.7	485	507	6.9	11.7	502	445	7.2	11.7	469	528	6.4	11.5	444	546	5.7	11.6	341	526	4.1	11.0	290	460	3.2	10.7	264	459	2.8	10.3	403	459	5.1	11.4
Lynn	285	490	3.1	10.0	343	447	4.0	10.3	404	435	5.0	11.9	458	475	6.1	11.8	504	503	6.9	12.2	499	499	7.0	12.0	511	406	7.2	12.2	471	499	6.4	12.0	448	519	5.7	12.0	351	505	4.2	11.0	300	442	3.3	10.6	269	426	2.9	10.1	411	426	5.2	11.5
Madison	248	537	2.7	10.9	294	443	3.4	11.0	326	402	4.1	11.3	386	439	5.1	11.6	413	520	5.9	12.1	419	492	6.0	11.9	436	443	6.4	12.2	423	422	5.8	11.7	392	448	5.0	11.5	302	547	3.6	11.4	254	572	2.9	11.2	220	537	2.4	10.8	337	537	4.4	12.3
Marion	231	514	2.5	10.9	282	407	3.3	11.4	298	381	3.8	12.5	357	384	4.8	12.5	385	445	5.6	13.5	380	469	5.6	12.8	410	471	6.1	14.1	399	377	5.6	13.3	370	544	4.8	12.6	286	491	3.4	11.8	234	564	2.7	11.4	199	533	2.2	11.0	316	533	4.2	11.6
Martin	288	415	3.2	9.6	349	325	4.0	10.1	418	360	5.2	12.6	471	390	6.2	12.3	528	415	7.0	13.0	525	419	7.1	12.5	528	323	7.4	13.0	474	407	6.4	12.8	454	430	5.6	12.7	371	415	4.5	11.0	315	320	3.4	10.2	277	288	3.1	9.7	425	288	5.3	10.6
Mason	264	568	2.9	11.0	300	509	3.5	10.9	344	394	4.3	10.8	392	538	5.3	11.2	424	566	6.2	11.3	426	554	6.3	11.4	459	354	6.8	11.3	443	414	6.1	8.7	411	524	5.3	9.4	293	550	3.6	11.4	246	576	2.7	11.4	234	431	2.6	8.5	352	431	4.6	11.2
Matagorda	251	541	2.7	10.9	294	467	3.4	10.9	333	431	4.2	10.8	393	497	5.2	11.4	420	537	5.9	11.7	428	472	6.1	11.6	441	455	6.3	11.5	421	441	5.7	11.2	397	395	5.0	11.2	311	587	3.7	11.2	263	573	3.0	11.2	227	537	2.5	11.0	345	537	4.4	11.8
Maverick	306	574	3.3	10.6	352	531	4.0	11.0	381	577	4.7	11.7	431	588	5.9	12.2	458	603	6.3	12.6	454	444	6.5	13.6	491	392	7.0	13.1	480	532	6.3	12.1	445	519	5.6	12.0	328	616	3.9	11.6	293	346	3.1	11.0	276	277	2.9	10.5	399	277	5.0	10.5

	Jan				Feb				Mar				Apr				May				Jun				Jul				Aug				Sep				Oct				Nov				Dec				Annual			
County	α	β	γ	τ	α	β	γ	τ	α	β	γ	τ	α	β	γ	τ	α	β	γ	τ	α	β	γ	τ	α	β	γ	τ	α	β	γ	τ	α	β	γ	τ	α	β	γ	τ	α	β	γ	τ	α	β	γ	τ	α	β	γ	τ
McCulloch	263	566	2.9	11.0	300	517	3.5	10.9	346	380	4.4	10.8	393	538	5.4	11.1	425	566	6.2	11.2	426	560	6.3	11.3	460	357	6.8	11.3	442	410	6.1	8.5	412	536	5.3	9.2	292	542	3.6	11.4	244	577	2.7	11.4	234	430	2.6	8.4	352	430	4.6	11.2
McLennan	257	535	2.8	10.8	303	422	3.5	10.8	336	405	4.2	11.1	393	437	5.2	11.3	424	531	6.1	11.6	432	517	6.3	11.7	451	392	6.6	11.7	445	445	6.1	11.1	404	457	5.2	11.2	302	550	3.6	11.2	258	567	2.9	11.1	228	530	2.5	10.5	347	530	4.5	11.5
McMullen	275	526	2.9	11.1	319	419	3.6	10.9	348	532	4.3	11.4	407	540	5.4	11.8	436	542	6.1	12.0	448	389	6.4	12.3	460	348	6.7	12.0	446	444	6.1	11.7	413	461	5.4	11.5	323	628	3.9	11.2	275	480	3.1	11.1	252	440	2.7	11.0	367	440	4.7	11.3
Medina	278	556	3.0	10.9	323	468	3.7	10.9	357	497	4.5	11.3	410	532	5.5	11.6	441	565	6.2	11.9	446	469	6.4	12.3	470	367	6.8	11.9	457	468	6.2	11.1	421	486	5.4	11.1	316	597	3.8	11.3	273	486	3.0	11.1	251	421	2.7	10.3	372	421	4.7	10.2
Menard	258	576	2.8	11.0	285	539	3.4	11.0	335	362	4.2	10.6	379	569	5.2	11.0	410	570	6.1	11.1	412	573	6.1	11.1	452	339	6.8	11.1	431	369	6.0	7.3	403	542	5.2	8.2	281	528	3.5	11.5	228	596	2.5	11.5	227	389	2.5	7.2	342	389	4.5	11.6
Midland	290	389	3.2	9.9	351	287	4.1	10.3	417	334	5.2	12.4	467	362	6.2	12.2	521	386	7.0	12.8	514	394	7.1	12.4	524	304	7.4	12.8	476	381	6.4	12.5	455	402	5.7	12.5	365	387	4.4	11.1	311	281	3.4	10.5	277	247	3.1	9.9	422	247	5.3	11.0
Milam	251	553	2.7	10.9	299	413	3.4	10.8	327	419	4.1	10.9	383	431	5.1	11.1	416	541	5.9	11.3	429	528	6.3	11.4	448	384	6.6	11.2	446	453	6.0	11.0	400	425	5.1	11.1	296	575	3.5	11.2	256	600	2.8	11.1	223	569	2.4	10.6	344	569	4.4	10.9
Mills	265	546	2.9	10.9	312	466	3.6	10.8	353	399	4.4	10.9	404	480	5.4	11.1	437	554	6.3	11.3	440	540	6.5	11.5	464	383	6.8	11.3	453	459	6.2	10.2	418	507	5.4	10.5	302	562	3.7	11.3	261	558	2.9	11.2	238	498	2.6	9.9	360	498	4.7	11.5
Mitchell	283	514	3.1	10.0	343	461	4.0	10.3	405	410	5.0	12.2	457	472	6.1	11.9	507	527	6.9	12.6	504	519	6.9	12.2	513	391	7.3	12.6	470	488	6.4	12.1	448	529	5.6	12.2	352	526	4.3	11.0	302	481	3.3	10.5	268	454	3.0	9.8	411	454	5.2	10.8
Montague	271	464	2.9	10.2	303	404	3.4	10.3	352	394	4.4	10.8	422	449	5.6	10.8	446	492	6.3	11.3	448	497	6.5	11.2	459	440	6.8	11.4	456	468	6.2	10.8	404	457	5.2	10.7	319	467	3.8	10.9	253	452	2.8	10.7	228	432	2.4	10.2	358	432	4.6	11.1
Montgomery	245	537	2.7	10.8	290	472	3.3	10.9	328	381	4.1	10.6	391	469	5.1	11.4	416	545	5.8	11.6	420	499	6.0	11.5	433	487	6.2	11.5	411	430	5.5	11.1	388	403	4.9	11.1	304	572	3.6	11.2	258	583	2.9	11.1	218	553	2.4	10.9	338	553	4.3	10.6
Moore	280	487	2.9	10.1	325	510	3.8	10.1	381	485	4.7	10.4	446	517	6.0	10.6	475	504	6.8	10.8	467	495	6.8	11.0	493	519	7.1	10.5	462	574	6.3	10.9	439	581	5.7	10.9	327	554	3.8	10.8	276	455	3.0	10.7	255	490	2.6	10.6	388	490	5.0	12.2
Morris	233	509	2.5	10.8	283	405	3.3	11.3	300	382	3.8	12.5	360	388	4.8	12.4	388	445	5.6	13.4	383	470	5.6	12.7	412	471	6.1	14.0	402	381	5.7	13.2	372	545	4.8	12.5	286	490	3.4	11.7	234	556	2.7	11.3	200	527	2.2	11.0	317	527	4.2	11.0
Motley	279	503	3.0	10.3	331	484	3.9	10.4	384	446	4.8	11.0	443	491	6.0	11.1	477	517	6.7	11.4	472	516	6.8	11.5	491	459	7.1	11.4	466	535	6.4	11.2	438	549	5.6	11.2	329	533	3.9	11.0	281	479	3.1	10.8	255	484	2.7	10.4	390	484	5.0	12.2
Nacogdoches	232	524	2.5	10.9	283	423	3.3	11.4	301	383	3.9	12.4	360	386	4.8	12.4	387	461	5.6	13.4	386	472	5.6	12.7	411	465	6.1	13.9	399	376	5.6	13.2	372	523	4.8	12.5	290	494	3.5	11.7	238	575	2.7	11.4	202	543	2.2	11.1	318	543	4.2	11.6
Navarro	251	518	2.7	10.8	297	421	3.4	11.0	327	395	4.1	11.6	387	423	5.2	11.7	416	498	5.9	12.3	418	492	6.1	12.1	439	428	6.4	12.6	430	419	5.9	11.9	394	486	5.1	11.7	301	518	3.6	11.4	251	548	2.8	11.1	220	514	2.4	10.6	338	514	4.4	12.2
Newton	252	590	2.8	10.9	290	547	3.3	11.4	325	404	4.2	12.3	396	343	5.1	12.4	410	579	5.8	13.3	444	488	6.1	12.6	418	365	6.1	13.8	415	372	5.7	13.1	386	397	5.0	12.5	338	439	4.0	11.7	266	626	3.0	11.4	226	568	2.5	11.1	344	568	4.4	11.2
Nolan	275	538	3.0	10.7	337	488	4.0	10.7	388	383	4.9	11.4	436	458	5.9	11.2	475	553	6.8	11.8	470	552	6.8	11.7	488	414	7.1	11.8	468	508	6.5	11.1	442	559	5.7	11.4	318	557	3.9	11.2	283	540	3.1	11.2	255	534	2.8	10.5	390	534	5.1	11.3
Nueces	240	486	2.7	11.3	280	418	3.3	11.0	306	477	3.9	11.0	372	565	4.9	11.4	397	496	5.8	11.5	405	399	6.0	11.2	422	372	6.3	11.1	410	445	5.7	11.1	400	366	5.2	11.1	305	650	3.8	11.3	257	626	3.0	11.6	232	576	2.5	11.6	335	576	4.4	10.8
Ochiltree	279	487	2.9	10.1	325	478	3.7	10.3	372	466	4.6	10.8	444	498	5.9	10.9	470	498	6.7	11.2	468	502	6.8	11.3	482	482	7.0	11.2	466	541	6.4	11.0	431	535	5.5	11.0	325	505	3.8	10.9	274	460	3.0	10.6	250	470	2.6	10.4	383	470	4.9	10.6
Oldham	280	489	2.9	10.1	327	514	3.8	10.2	384	488	4.7	10.4	448	519	6.0	10.7	478	507	6.8	10.8	469	497	6.9	11.0	495	520	7.1	10.5	462	576	6.4	10.9	441	586	5.7	10.9	329	557	3.8	10.8	277	458	3.0	10.7	257	492	2.7	10.6	390	492	5.0	12.2
Orange	253	600	2.8	10.9	289	568	3.3	11.4	327	403	4.2	12.2	400	339	5.2	12.3	411	599	5.8	13.2	450	492	6.1	12.6	417	356	6.1	13.7	414	371	5.7	13.0	387	378	5.0	12.4	344	436	4.1	11.7	270	634	3.1	11.4	227	574	2.5	11.1	348	574	4.5	11.0
Palo Pinto	269	519	2.9	10.7	319	456	3.7	10.7	362	389	4.6	11.0	418	458	5.6	11.0	449	529	6.4	11.5	449	534	6.6	11.5	467	424	6.9	11.5	458	485	6.3	10.8	421	509	5.4	10.9	310	533	3.8	11.2	266	530	2.9	11.1	240	510	2.6	10.4	366	510	4.8	12.4
Panola	229	518	2.5	10.9	281	410	3.3	11.4	296	380	3.8	12.6	354	380	4.8	12.5	382	445	5.5	13.5	378	468	5.5	12.8	407	471	6.0	14.2	396	371	5.6	13.4	369	543	4.8	12.7	285	490	3.4	11.8	233	571	2.7	11.4	198	540	2.2	11.1	314	540	4.1	11.0
Parker	267	509	2.9	10.6	312	439	3.6	10.6	353	393	4.4	11.0	413	452	5.5	11.1	443	516	6.3	11.5	445	519	6.5	11.5	461	425	6.8	11.6	453	468	6.2	10.9	413	485	5.3	11.0	311	516	3.8	11.2	261	519	2.9	11.0	235	492	2.5	10.4	358	492	4.7	10.8
Parmer	282	497	3.0	10.2	331	510	3.9	10.3	389	488	4.8	10.7	451	519	6.1	10.9	483	514	6.9	11.0	474	505	6.9	11.2	497	501	7.1	10.9	465	566	6.4	11.1	443	578	5.7	11.1	333	549	3.9	10.9	282	464	3.1	10.7	261	488	2.7	10.5	395	488	5.1	11.8
Pecos	305	603	3.5	11.3	373	594	4.4	11.4	437	596	5.5	11.8	470	619	6.5	12.0	515	627	7.3	12.1	490	612	7.2	12.3	526	407	7.5	11.8	490	617	6.8	12.0	468	633	6.2	12.0	354	606	4.4	11.6	308	605	3.4	11.6	292	588	3.2	11.4	422	588	5.5	11.6
Polk	245	543	2.7	10.9	289	472	3.3	11.1	322	389	4.1	11.4	386	425	5.1	11.8	409	529	5.8	12.4	418	488	5.9	12.0	427	456	6.2	12.5	411	406	5.6	12.0	385	434	4.9	11.7	308	527	3.7	11.4	255	584	2.9	11.2	217	548	2.4	11.0	335	548	4.3	10.5
Potter	279	480	2.9	10.0	322	516	3.8	10.1	381	486	4.7	10.1	446	518	6.0	10.4	474	498	6.8	10.5	465	486	6.8	10.8	496	535	7.1	10.2	459	584	6.3	10.7	441	594	5.7	10.7	325	569	3.7	10.7	273	448	3.0	10.7	254	496	2.6	10.6	385	496	5.0	12.2
Presidio	324	625	3.8	11.2	393	652	4.7	11.0	465	644	5.9	12.3	476	658	6.6	12.7	533	660	7.5	12.7	511	650	7.4	14.0	524	593	7.4	13.4	497	656	6.9	13.0	476	669	6.3	12.7	388	646	4.8	11.1	322	647	3.7	10.7	302	653	3.4	11.0	437	653	5.7	12.0
Rains	240	505	2.6	10.8	288	406	3.3	11.2	311	383	4.0	12.1	371	400	5.0	12.1	399	456	5.7	13.0	396	477	5.8	12.5	422	462	6.2	13.5	413	395	5.8	12.7	379	524	4.9	12.2	292	491	3.5	11.6	239	545	2.7	11.2	207	515	2.2	10.8	324	515	4.2	10.4
Randall	278	477	2.8	10.0	321	518	3.8	10.0	381	486	4.7	10.0	446	519	6.0	10.4	473	496	6.9	10.4	463	483	6.8	10.7	496	542	7.1	10.1	458	589	6.3	10.7	442	599	5.7	10.7	324	575	3.7	10.7	272	445	3.0	10.7	254	498	2.6	10.7	384	498	5.0	11.5
Reagan	290	505	3.2	10.3	348	451	4.1	10.6	408	447	5.1	12.0	456	491	6.1	12.0	502	516	6.9	12.5	495	499	6.9	12.4	513	366	7.3	12.5	474	485	6.4	12.0	451	512	5.7	12.1	350	510	4.3	11.2	301	442	3.3	10.8	273	401	3.0	10.1	412	401	5.2	11.2
Real	284	573	3.1	10.8	326	525	3.8	10.9	364	487	4.6	11.3	413	563	5.6	11.7	443	582	6.3	12.0	441	509	6.4	12.4	477	384	6.9	12.1	462	486	6.2	10.5	430	514	5.5	10.7	312	581	3.8	11.5	271	471	2.9	11.2	255	370	2.7	9.6	377	370	4.8	11.8
Red River	245	498	2.6	10.6	290	409	3.3	11.0	316	387	4.0	12.0	381	405	5.1	11.9	406	459	5.8	12.8	406	477	5.9	12.3	427	461	6.3	13.3	420	405	5.8	12.5	382	506	4.9	12.0	298	477	3.6	11.5	242	530	2.7	11.1	210	501	2.3	10.7	329	501	4.3	11.9
Reeves	300	624	3.5	11.8	376	597	4.5	11.8	449	625	5.7	12.0	486	641	6.8	12.0	542	640	7.8	12.1	501	628	7.5	12.1	532	403	7.6	12.1	499	636	7.0	12.0	475	663	6.3	12.0	373	605	4.6	11.5	314	652	3.5	11.8	299	643	3.3	11.8	430	643	5.7	11.3
Refugio	247	507	2.7	11.2	288	428	3.4	11.0	317	479	4.0	11.1	380	546	5.0	11.4	407	507	5.9	11.6	417	416	6.1	11.4	432	383	6.4	11.3	420	447	5.8	11.2	402	382	5.2	11.1	309	631	3.8	11.3	260	600	3.0	11.5	234	553	2.5	11.3	341	553	4.5	10.8
Roberts	279	487	2.9	10.1	324	484	3.8	10.2	375	467	4.7	10.7	444	500	5.9	10.8	471	500	6.7	11.1	468	500	6.8	11.2	485	488	7.0	11.0	464	547	6.4	11.0	433	546	5.6	10.9	326	519	3.8	10.9	274	459	3.0	10.7	251	474	2.6	10.4	384	474	4.9	11.3
Robertson	252	542	2.7	10.9	298	431	3.4	10.9	329	412	4.2	11.1	388	440	5.1	11.4	418	529	5.9	11.7	426	505	6.2	11.7	444	415	6.5	11.7	436	437	5.9	11.3	398	442	5.1	11.3	301	558	3.6	11.3	256	576	2.9	11.1	223	542	2.4	10.7	342	542	4.4	11.5
Rockwall	253	500	2.7	10.6	296	415	3.4	10.9	329	389	4.2	11.6	392	421	5.2	11.6	419	480	6.0	12.3	420	490	6.1	12.0	439	447	6.5	12.6	431	425	6.0	11.9	392	487	5.0	11.6	304	491	3.6	11.3	248	525	2.8	11.1	218	495	2.4	10.6	338	495	4.4	11.0
Runnels	271	550	3.0	11.0	327	501	3.9	10.9	374	377	4.7	11.1	420	478	5.7	11.1	455	562	6.6	11.5	451	560	6.6	11.5	476	401	7.0	11.5	461	483	6.4	10.2	433	558	5.6	10.6	304	559	3.7	11.3	269	559	3.0	11.4	247	517	2.7	10.1	375	517	4.9	12.6
Rusk	221	511	2.4	11.0	276	392	3.2	11.5	285	372	3.7	12.9	340	372	4.6	12.7	370	421	5.4	13.8	360	464	5.3	13.0	398	486	5.9	14.6	386	361	5.5	13.7	361	576	4.7	12.9	274	492	3.3	11.9	225	571	2.6	11.5	189	542	2.1	11.2	306	542	4.1	12.1
Sabine	246	558	2.7	10.9	289	489	3.3	11.3	319	398	4.1	12.1	385	375	5.1	12.2	405	529	5.7	13.1	423	482	5.9	12.5	421	412	6.2	13.5	413	382	5.7	12.8	384	444	4.9	12.3	318	471	3.8	11.7	256	597	2.9	11.3	218	552	2.4	11.0	335	552	4.3	12.1
San Augustine	242	544	2.6	10.9	288	464	3.3	11.3	314	393	4.0	12.1	378	385	5.0	12.2	401	505	5.7	13.1	411	479	5.8	12.5	419	435	6.2	13.5	409	384	5.7	12.8	381	469	4.9	12.3	307	485	3.7	11.7	250	587	2.8	11.3	213	548	2.3	11.0	330	548	4.3	11.4
San Jacinto	245	539	2.7	10.8	290	472	3.3	11.0	326	384	4.1	10.9	389	450	5.1	11.6	413	538	5.8	12.0	419	494	6.0	11.7	430	474	6.2	12.0	411	420	5.6	11.5	387	417	4.9	11.4	306	552	3.7	11.3	257	582	2.9	11.2	218	549	2.4	11.0	337	549	4.3	11.2
San Patricio	238	482	2.7	11.3	278	417	3.3	11.0	304	472	3.9	11.0	370	567	4.9	11.4	395	497	5.8	11.4	403	400	6.0	11.1	419	367	6.2	11.1	408	444	5.6	11.1	399	366	5.2	11.0	303	654	3.7	11.3	256	634	3.0	11.6	231	584	2.5	11.6	333	584	4.4	10.8
San Saba	264	555	2.9	10.9	308	476	3.6	10.9	349	400	4.4	10.9	399	498	5.4	11.1	432	559	6.2	11.3	435	545	6.4	11.4	462	370	6.8	11.3	450	444	6.2	9.7	415	507	5.4	10.2	299	560	3.6	11.3	256	567	2.8	11.3	236	479	2.6	9.5	357	479	4.7	10.9
Schleicher	275	566	3.0	10.8	316	527	3.7	10.9	365	427	4.6	11.1	411	554	5.6	11.4	445	571	6.4	11.6	442	549	6.5	11.8	476	369	7.0	11.7	453	451	6.2	9.5	425	540	5.5	10.0	308	552	3.8	11.5	261	538	2.9	11.3	248	412	2.7	8.9	371	412	4.8	11.4
Scurry	282	514	3.1	10.1	341	464	4.0	10.4	400	412	5.0	11.9	453	469	6.1	11.8	500	527	6.9	12.3	496	522	6.9	12.1	507	403	7.2	12.4	470	499	6.4	11.9	446	534	5.6	12.0	345	527	4.2	11.1	298	486	3.3	10.6	266	469	2.9	10.0	407	469	5.2	11.2
Shackelford	270	543	3.0	11.1	338	490	4.0	10.9	382	354	4.8	11.0	428	427	5.9	10.8	462	558	6.8	11.4	455	569	6.8	11.4	477	435	7.1	11.4	469	524	6.6	10.9	441	573	5.7	11.2	299	569	3.7	11.3	276	570	3.0	11.5	248	596	2.7	11.2	379	596	5.0	12.2
Shelby	236	531	2.6	10.9	285	436	3.3	11.4	306	388	3.9	12.3	367	384	4.9	12.3	392	475	5.6	13.3	395	473	5.7	12.7	414	452	6.1	13.8	404	378	5.7	13.1	376	506	4.9	12.5	297	488	3.6	11.7	242	578	2.8	11.4	206	542	2.2	11.0	322	542	4.2	10.7
Sherman	280	493	2.9	10.1	327	505	3.8	10.2	380	484	4.7	10.6	447	515	6.0	10.8	476	509	6.8	11.0	470	503	6.8	11.2	490	504	7.0	10.9	464	563	6.4	11.0	437	567	5.6	11.0	329	537	3.8	10.8	277	462	3.0	10.7	255	484	2.7	10.5	390	484	5.0	12.5
Smith	221	509	2.4	11.0	276	390	3.2	11.5	285	372	3.7	12.8	340	373	4.6	12.7	371	420	5.4	13.8	360	464	5.4	13.0	399	486	6.0	14.5	387	363	5.5	13.7	361	577	4.7	12.9	274	492	3.3	11.9	225	568	2.6	11.5	189	540	2.1	11.1	306	540	4.1	11.1

	Jan				Feb				Mar				Apr				May				Jun			
County	α	β	γ	τ	α	β	γ	τ	α	β	γ	τ	α	β	γ	τ	α	β	γ	τ	α	β	γ	τ
Somervell	264	522	2.9	10.7	311	436	3.6	10.7	350	397	4.4	11.1	407	452	5.5	11.2	438	526	6.2	11.6	441	517	6.4	11.6
Starr	269	555	2.9	11.1	314	371	3.6	10.9	351	583	4.3	11.2	408	527	5.3	11.4	451	478	6.1	11.8	456	391	6.3	11.7
Stephens	270	532	3.0	10.9	328	476	3.9	10.8	372	375	4.7	11.0	423	448	5.7	10.9	456	544	6.6	11.4	453	552	6.7	11.4
Sterling	285	511	3.1	10.0	343	457	4.0	10.3	405	421	5.0	12.2	457	484	6.1	12.0	507	523	6.9	12.6	504	510	6.9	12.3
Stonewall	275	530	3.0	10.7	336	483	4.0	10.7	385	388	4.8	11.3	436	454	5.9	11.1	472	543	6.8	11.7	467	549	6.8	11.6
Sutton	281	572	3.1	10.8	324	539	3.8	10.9	369	461	4.6	11.2	415	567	5.7	11.6	447	582	6.4	11.8	442	540	6.5	12.1
Swisher	279	483	2.9	10.1	324	512	3.8	10.1	383	482	4.7	10.3	446	516	6.0	10.6	475	501	6.8	10.6	467	489	6.8	10.9
Tarrant	263	503	2.8	10.5	306	427	3.5	10.7	345	391	4.4	11.2	407	440	5.4	11.2	435	504	6.2	11.7	438	506	6.4	11.6
Taylor	270	547	3.0	11.2	341	495	4.1	11.0	385	347	4.8	11.1	429	423	5.9	10.8	464	563	6.8	11.4	456	574	6.8	11.4
Terrell	309	637	3.6	11.3	376	653	4.5	11.3	436	638	5.5	11.6	466	663	6.5	12.0	504	669	7.2	12.1	481	648	7.1	12.2
Terry	287	490	3.2	10.2	345	447	4.0	10.5	405	446	5.0	11.7	459	480	6.2	11.7	504	502	6.9	12.1	495	498	7.0	12.0
Throckmorton	272	530	3.0	10.9	331	478	3.9	10.8	376	376	4.7	11.1	428	445	5.8	10.9	461	544	6.7	11.5	457	553	6.7	11.5
Titus	235	507	2.6	10.8	284	405	3.3	11.3	303	383	3.9	12.4	363	392	4.9	12.3	391	448	5.6	13.2	387	471	5.7	12.6
Tom Green	274	552	3.0	10.7	321	508	3.8	10.8	372	409	4.7	11.2	419	526	5.7	11.4	456	560	6.5	11.7	453	546	6.6	11.7
Travis	243	568	2.7	11.0	293	375	3.3	10.7	312	417	3.9	10.7	366	396	4.8	10.7	403	553	5.8	10.7	425	571	6.3	11.1
Trinity	242	534	2.6	10.9	289	447	3.3	11.2	317	390	4.0	11.6	378	418	5.0	11.9	404	503	5.7	12.6	408	483	5.9	12.2
Tyler	247	558	2.7	10.9	290	497	3.3	11.2	323	394	4.1	11.7	389	398	5.1	12.0	410	544	5.8	12.7	426	488	6.0	12.2
Upshur	223	509	2.4	10.9	277	393	3.2	11.5	288	374	3.7	12.8	343	375	4.6	12.6	373	424	5.4	13.8	364	465	5.4	13.0
Upton	294	471	3.3	10.5	355	404	4.2	10.8	417	426	5.2	12.0	461	458	6.3	12.1	508	478	7.0	12.4	496	472	7.0	12.4
Uvalde	291	569	3.1	10.7	336	515	3.8	10.9	369	526	4.6	11.4	420	566	5.7	11.8	449	585	6.3	12.2	448	475	6.5	12.8
Val Verde	309	596	3.4	10.5	359	597	4.1	11.0	393	573	4.9	11.6	438	615	6.1	12.1	465	619	6.4	12.6	449	519	6.5	13.4
Van Zandt	237	509	2.6	10.8	287	405	3.3	11.2	307	383	3.9	12.2	366	397	4.9	12.2	395	455	5.7	13.1	391	474	5.7	12.6
Victoria	253	532	2.8	11.1	296	439	3.4	11.0	329	470	4.1	11.0	388	514	5.1	11.4	417	524	5.9	11.6	428	449	6.2	11.6
Walker	247	537	2.7	10.9	292	457	3.3	11.0	326	393	4.1	11.1	387	446	5.1	11.6	413	528	5.8	12.0	419	492	6.0	11.8
Waller	248	539	2.7	10.8	293	462	3.3	10.9	330	396	4.1	10.6	392	471	5.2	11.3	418	544	5.9	11.5	424	497	6.1	11.5
Ward	299	580	3.5	11.5	371	542	4.4	11.6	441	568	5.6	12.0	479	587	6.6	12.0	533	594	7.6	12.1	499	583	7.3	12.2
Washington	251	545	2.7	10.9	297	440	3.4	10.9	330	414	4.1	10.9	389	455	5.1	11.3	418	539	5.9	11.5	427	504	6.2	11.5
Webb	321	521	3.1	11.2	366	373	3.9	10.9	383	637	4.7	12.2	445	549	5.7	12.6	473	612	6.4	12.7	496	270	6.8	14.1
Wharton	251	541	2.7	10.9	295	460	3.4	10.9	332	421	4.2	10.7	392	486	5.2	11.4	419	541	5.9	11.6	427	484	6.1	11.5
Wheeler	278	485	2.9	10.1	323	467	3.7	10.3	371	452	4.6	10.8	441	489	5.9	10.9	468	497	6.6	11.3	467	503	6.8	11.4
Wichita	274	482	2.9	10.3	313	432	3.6	10.4	362	404	4.6	10.9	430	463	5.7	10.9	456	507	6.5	11.3	456	516	6.7	11.3
Wilbarger	275	495	2.9	10.4	320	449	3.7	10.5	368	407	4.6	11.0	432	465	5.8	11.0	461	514	6.5	11.4	460	522	6.7	11.4
Willacy	257	599	2.8	11.1	294	461	3.4	11.2	350	608	4.3	11.3	394	540	5.1	11.7	431	430	5.9	12.5	458	376	6.3	11.8
Williamson	246	564	2.7	11.0	295	386	3.4	10.7	317	417	4.0	10.8	372	408	4.9	10.8	408	551	5.9	10.9	427	559	6.3	11.2
Wilson	261	545	2.8	11.0	306	429	3.5	10.9	336	473	4.2	11.1	393	496	5.2	11.4	424	541	6.0	11.5	436	472	6.3	11.7
Winkler	297	541	3.4	11.3	366	493	4.3	11.4	434	518	5.5	12.0	475	540	6.5	12.0	527	552	7.4	12.2	499	543	7.3	12.2
Wise	268	489	2.9	10.4	308	423	3.5	10.5	352	392	4.4	11.0	417	447	5.6	11.0	443	503	6.3	11.5	445	506	6.5	11.4
Wood	229	508	2.5	10.9	281	397	3.3	11.4	295	377	3.8	12.6	352	383	4.7	12.5	382	435	5.5	13.5	374	468	5.5	12.8
Yoakum	289	506	3.2	10.4	348	467	4.1	10.6	408	469	5.1	11.7	460	500	6.2	11.7	504	519	7.0	12.0	493	513	7.0	12.0
Young	271	518	3.0	10.7	323	463	3.8	10.7	368	387	4.6	11.0	425	455	5.7	11.0	456	532	6.5	11.4	454	540	6.6	11.4
Zapata	305	532	3.1	11.2	350	379	3.8	10.9	374	621	4.6	11.9	434	544	5.6	12.3	465	573	6.3	12.5	484	304	6.6	13.4
Zavala	296	560	3.2	10.8	342	488	3.9	10.9	373	556	4.6	11.6	425	565	5.7	12.0	454	588	6.3	12.3	457	432	6.5	13.1

	Jul				Aug				Sep				Oct				Nov				Dec				Annual			
County	α	β	γ	τ	α	β	γ	τ	α	β	γ	τ	α	β	γ	τ	α	β	γ	τ	α	β	γ	τ	α	β	γ	τ
Somervell	460	406	6.7	11.7	451	457	6.2	10.9	413	484	5.3	11.0	308	536	3.7	11.2	262	534	2.9	11.1	235	499	2.5	10.3	356	499	4.6	11.3
Starr	474	426	6.6	11.4	450	527	6.0	11.6	407	382	5.2	11.1	334	630	3.9	11.1	273	526	3.0	10.8	239	496	2.6	11.0	370	496	4.6	11.1
Stephens	473	427	7.0	11.5	463	503	6.4	10.8	431	541	5.6	11.0	306	549	3.7	11.3	271	548	3.0	11.3	245	545	2.7	10.7	373	545	4.9	11.5
Sterling	514	376	7.3	12.7	470	478	6.4	12.1	448	519	5.6	12.2	354	520	4.3	11.1	303	466	3.3	10.5	270	422	3.0	9.7	412	422	5.2	11.2
Stonewall	485	430	7.1	11.7	468	517	6.5	11.2	440	556	5.7	11.4	317	549	3.9	11.2	281	533	3.1	11.2	253	539	2.8	10.7	387	539	5.0	11.1
Sutton	480	381	7.0	11.9	460	480	6.3	10.0	431	537	5.5	10.4	311	567	3.8	11.5	268	505	2.9	11.3	254	389	2.7	9.2	377	389	4.9	10.5
Swisher	496	525	7.1	10.4	460	578	6.3	10.8	441	589	5.7	10.8	327	565	3.8	10.7	275	451	3.0	10.7	255	493	2.6	10.6	387	493	5.0	11.1
Tarrant	454	429	6.7	11.9	447	451	6.1	11.1	406	472	5.2	11.1	310	503	3.7	11.2	257	517	2.8	11.0	229	487	2.5	10.4	351	487	4.6	11.2
Taylor	478	436	7.1	11.4	471	528	6.6	10.9	445	582	5.8	11.3	297	576	3.7	11.3	278	577	3.1	11.6	250	609	2.7	11.3	381	609	5.0	11.8
Terrell	528	413	7.6	11.5	489	660	6.8	12.0	470	664	6.2	12.0	343	649	4.3	11.9	307	645	3.4	11.7	293	627	3.2	11.6	419	627	5.5	11.3
Terry	509	403	7.2	12.1	473	501	6.4	11.9	449	520	5.7	11.9	350	502	4.2	11.1	299	440	3.3	10.7	271	424	2.9	10.3	411	424	5.2	11.1
Throckmorton	476	433	7.0	11.5	466	512	6.5	10.9	434	549	5.6	11.1	308	548	3.8	11.2	274	543	3.0	11.3	247	550	2.7	10.8	377	550	4.9	12.1
Titus	415	469	6.2	13.8	405	386	5.7	13.0	374	539	4.8	12.4	288	489	3.5	11.7	235	551	2.7	11.3	202	522	2.2	10.9	319	522	4.2	10.9
Tom Green	481	374	7.0	11.7	456	455	6.3	10.0	429	540	5.5	10.4	314	545	3.8	11.3	268	534	2.9	11.2	250	435	2.7	9.2	377	435	4.9	10.8
Travis	445	343	6.6	10.4	457	471	6.1	10.7	396	402	5.1	11.0	280	593	3.3	11.0	251	651	2.8	11.0	214	635	2.3	10.6	340	635	4.4	11.8
Trinity	425	458	6.2	12.9	411	401	5.7	12.2	383	466	4.9	11.9	301	522	3.6	11.5	249	577	2.8	11.3	213	542	2.3	11.0	330	542	4.3	11.8
Tyler	424	427	6.2	13.0	412	394	5.7	12.4	386	422	4.9	12.0	318	496	3.8	11.5	259	598	2.9	11.3	220	555	2.4	11.0	338	555	4.4	12.5
Upshur	401	484	6.0	14.5	389	366	5.6	13.6	363	572	4.7	12.9	276	492	3.3	11.9	226	567	2.6	11.4	191	538	2.1	11.1	308	538	4.1	11.6
Upton	518	347	7.4	12.4	479	465	6.5	12.1	456	485	5.8	12.1	353	473	4.3	11.3	305	399	3.3	11.0	279	366	3.1	10.5	417	366	5.3	11.5
Uvalde	481	386	6.9	12.5	468	503	6.3	11.3	434	507	5.5	11.3	320	599	3.9	11.5	281	427	3.0	11.1	263	349	2.8	10.2	385	349	4.9	11.8
Val Verde	503	433	7.2	13.0	489	594	6.4	12.0	460	531	5.7	11.9	326	610	3.9	11.8	297	383	3.2	11.2	282	303	3.0	10.5	405	303	5.1	12.1
Van Zandt	419	461	6.2	13.6	409	389	5.7	12.9	377	530	4.9	12.3	290	496	3.5	11.6	238	551	2.7	11.3	205	520	2.2	10.9	322	520	4.2	11.3
Victoria	443	398	6.5	11.4	431	449	5.8	11.2	404	402	5.2	11.2	311	607	3.8	11.3	263	579	3.0	11.3	233	537	2.5	11.1	347	537	4.5	11.4
Walker	433	460	6.3	12.1	417	421	5.7	11.6	389	433	4.9	11.5	304	550	3.6	11.3	255	576	2.9	11.2	219	542	2.4	10.9	337	542	4.3	11.1
Waller	438	466	6.3	11.4	419	436	5.6	11.0	392	404	4.9	11.1	304	577	3.6	11.2	259	580	2.9	11.1	222	549	2.4	10.9	341	549	4.4	11.8
Ward	527	389	7.6	12.1	494	587	6.9	12.0	470	612	6.2	12.0	367	567	4.5	11.5	311	578	3.4	11.7	294	562	3.2	11.5	427	562	5.6	11.1
Washington	443	424	6.4	11.4	432	442	5.8	11.1	397	417	5.1	11.2	303	573	3.6	11.2	259	583	2.9	11.1	224	550	2.4	10.8	342	550	4.4	12.1
Webb	487	236	7.1	13.4	473	396	6.5	12.9	421	600	5.6	12.5	346	665	4.2	11.1	302	280	3.3	10.6	284	267	2.9	11.0	405	267	5.0	11.2
Wharton	441	450	6.4	11.4	423	442	5.7	11.1	397	401	5.0	11.1	308	586	3.7	11.2	261	578	2.9	11.1	226	543	2.4	10.9	344	543	4.4	10.8
Wheeler	480	471	7.0	11.3	465	530	6.4	11.0	429	526	5.5	11.0	324	499	3.8	10.9	272	460	2.9	10.7	247	464	2.6	10.3	381	464	4.9	10.9
Wichita	468	442	6.9	11.4	462	494	6.3	10.8	415	490	5.3	10.8	319	486	3.8	11.0	261	468	2.8	10.8	236	457	2.5	10.3	370	457	4.8	10.9
Wilbarger	473	441	6.9	11.5	464	503	6.4	10.9	423	508	5.4	11.0	319	502	3.8	11.0	268	484	2.9	10.9	242	477	2.6	10.4	375	477	4.8	11.5
Willacy	474	523	6.4	11.6	446	475	5.9	11.9	414	297	5.2	11.2	353	535	4.1	11.2	272	477	3.1	11.1	236	433	2.6	11.0	364	433	4.6	10.9
Williamson	447	352	6.6	10.6	455	467	6.1	10.7	399	411	5.1	11.0	285	589	3.4	11.1	253	635	2.8	11.0	218	613	2.4	10.6	342	613	4.4	11.2
Wilson	453	372	6.6	11.4	446	457	6.0	11.1	409	433	5.3	11.2	308	604	3.7	11.2	264	560	2.9	11.2	237	517	2.6	10.7	354	517	4.6	11.8
Winkler	524	379	7.5	12.2	490	544	6.8	12.1	466	568	6.1	12.0	364	532	4.5	11.4	309	515	3.4	11.5	290	495	3.2	11.3	425	495	5.5	11.0
Wise	459	433	6.7	11.6	453	464	6.2	10.9	409	472	5.2	10.9	314	493	3.8	11.1	258	491	2.8	10.9	231	466	2.5	10.3	357	466	4.6	12.3
Wood	408	476	6.1	14.2	397	374	5.6	13.4	368	557	4.8	12.7	281	492	3.4	11.8	230	559	2.6	11.4	196	530	2.1	11.0	313	530	4.1	11.4
Yoakum	508	412	7.3	12.0	475	517	6.5	11.8	451	536	5.8	11.8	350	514	4.2	11.1	298	462	3.3	10.9	273	448	2.9	10.5	412	448	5.3	11.0
Young	471	431	6.9	11.5	462	499	6.4	10.8	426	525	5.5	11.0	311	531	3.8	11.2	269	524	2.9	11.1	242	516	2.6	10.6	372	516	4.9	11.9
Zapata	482	294	6.9	12.9	466	429	6.3	12.6	418	535	5.5	12.1	343	650	4.1	11.1	293	348	3.2	10.7	272	330	2.8	11.0	395	330	4.9	11.7
Zavala	483	364	7.0	12.7	469	492	6.3	11.8	433	517	5.5	11.7	327	614	3.9	11.4	286	397	3.1	11.0	267	337	2.8	10.5	390	337	4.9	11

Table 12. Estimated monthly and annual averages of direct radiation by county in Texas. Average W/m^2 are represented by α, peak W/m^2 by β and total energy in $kWh/m^2/day$ by γ. Average daylight hours are estimated by τ.

	Jan				Feb				Mar				Apr				May				Jun				Jul				Aug				Sep				Oct				Nov				Dec				Annual			
County	α	β	γ	τ	α	β	γ	τ	α	β	γ	τ	α	β	γ	τ	α	β	γ	τ	α	β	γ	τ	α	β	γ	τ	α	β	γ	τ	α	β	γ	τ	α	β	γ	τ	α	β	γ	τ	α	β	γ	τ	α	β	γ	τ
Anderson	358	699	3.7	10.9	364	439	3.9	11.3	338	543	3.9	12.2	321	496	4.0	12.2	337	607	4.5	13.1	336	593	4.6	12.6	400	550	5.5	13.6	411	419	5.3	12.9	402	724	4.9	12.3	333	667	3.8	11.7	373	796	3.8	11.3	335	705	3.4	11.0	359	603	4.3	11.6
Andrews	505	866	5.4	10.5	505	526	5.9	10.8	544	663	6.5	12.1	518	702	6.9	12.0	550	852	7.5	12.4	524	858	7.1	12.3	582	722	8.0	12.4	528	809	7.0	12.2	571	880	7.1	12.2	509	790	5.9	11.2	495	678	5.3	10.9	517	298	5.5	10.5	530	720	6.5	12.0
Angelina	341	720	3.6	10.9	337	533	3.6	11.3	322	544	3.8	12.0	321	434	4.0	12.2	333	643	4.4	13.0	340	556	4.6	12.4	381	502	5.3	13.4	392	368	5.1	12.7	390	583	4.8	12.2	341	623	3.9	11.6	368	813	3.8	11.3	319	708	3.3	11.0	349	586	4.2	11.3
Aransas	311	628	3.3	11.2	314	423	3.5	11.0	296	526	3.5	11.1	300	592	3.8	11.5	337	605	4.5	11.6	365	356	5.1	11.4	429	360	6.0	11.3	417	365	5.4	11.2	432	350	5.4	11.1	341	782	4.0	11.3	346	760	3.7	11.5	322	624	3.4	11.3	351	531	4.3	11.0
Archer	468	710	4.8	10.5	432	557	4.9	10.5	438	508	5.2	11.0	427	539	5.6	10.9	445	658	6.1	11.4	433	769	6.1	11.4	499	592	7.0	11.5	495	722	6.6	10.8	498	769	6.2	10.9	405	773	4.7	11.1	403	823	4.2	11.0	426	770	4.4	10.4	448	683	5.5	10.5
Armstrong	477	755	5.0	10.1	483	821	5.5	10.1	477	542	5.8	10.3	479	682	6.4	10.5	499	740	6.9	10.6	473	620	6.7	10.9	520	728	7.3	10.3	498	856	6.6	10.8	561	910	7.1	10.8	418	859	4.7	10.7	462	705	5.0	10.7	466	630	4.9	10.6	485	737	6.0	11.4
Atascosa	387	653	4.0	11.0	374	494	4.1	10.9	348	626	4.2	11.3	348	620	4.4	11.6	367	717	4.9	11.8	390	439	5.5	12.1	459	344	6.5	11.8	448	491	5.9	11.3	446	534	5.7	11.3	351	786	4.1	11.3	371	620	3.9	11.1	373	521	3.9	10.7	390	571	4.8	11.1
Austin	349	691	3.6	10.9	329	535	3.6	10.9	319	529	3.8	10.7	315	510	4.0	11.3	335	665	4.5	11.5	357	504	5.0	11.5	403	474	5.7	11.4	397	483	5.2	11.1	405	431	5.1	11.1	331	739	3.8	11.2	352	760	3.9	11.1	330	664	3.5	10.8	352	582	4.3	11.0
Bailey	494	819	5.2	10.2	495	771	5.6	10.4	506	649	6.1	11.1	498	723	6.6	11.2	524	810	7.2	11.4	497	749	6.9	11.5	545	701	7.6	11.3	512	860	6.8	11.4	564	902	7.1	11.4	461	822	5.3	11.0	475	749	5.1	10.8	492	610	5.1	10.5	506	764	6.2	11.1
Bandera	432	755	4.5	10.9	400	590	4.5	10.9	384	619	4.6	11.2	380	700	5.0	11.5	399	804	5.4	11.7	397	602	5.7	12.1	496	392	7.0	11.8	475	573	6.2	10.5	480	645	6.0	10.8	358	763	4.1	11.4	379	650	4.0	11.2	403	561	4.2	9.9	417	638	5.1	10.9
Bastrop	383	818	4.0	11.0	350	440	3.9	10.7	314	539	3.8	10.8	300	502	3.7	10.9	332	754	4.4	11.0	371	669	5.2	11.2	421	330	5.9	10.7	423	555	5.6	10.8	413	446	5.2	11.0	292	726	3.3	11.1	363	858	4.0	11.0	370	739	3.8	10.6	361	615	4.4	11.0
Baylor	468	743	4.8	10.6	446	592	5.1	10.6	449	531	5.4	11.0	434	568	5.7	11.0	457	709	6.3	11.5	441	773	6.2	11.5	513	575	7.2	11.5	505	720	6.7	10.9	514	778	6.4	11.1	402	779	4.7	11.1	415	815	4.4	11.1	435	766	4.5	10.6	457	696	5.6	11.3
Bee	315	613	3.3	11.2	319	401	3.5	11.0	296	523	3.6	11.1	302	604	3.8	11.4	338	619	4.5	11.5	367	355	5.2	11.4	434	331	6.1	11.3	422	370	5.5	11.2	435	366	5.5	11.1	339	809	4.0	11.3	349	771	3.8	11.5	328	632	3.4	11.4	354	533	4.3	11.0
Bell	393	785	4.1	10.9	360	456	4.0	10.8	333	530	4.0	10.9	321	515	4.0	11.0	350	742	4.7	11.2	376	667	5.3	11.3	434	369	6.1	11.0	432	554	5.7	10.8	424	512	5.4	11.0	313	736	3.6	11.1	367	834	4.0	11.1	374	720	3.9	10.5	374	618	4.6	11.2
Bexar	398	728	4.1	11.0	375	506	4.2	10.9	351	598	4.2	11.1	345	611	4.4	11.4	367	748	5.0	11.6	388	551	5.5	11.8	460	364	6.5	11.5	449	532	5.9	11.0	448	546	5.7	11.1	338	762	3.9	11.3	371	693	4.0	11.1	380	591	3.9	10.5	390	603	4.8	10.9
Blanco	400	804	4.2	11.0	367	476	4.1	10.8	339	554	4.1	10.9	325	566	4.1	11.0	356	770	4.8	11.1	382	671	5.4	11.4	448	355	6.3	10.9	441	561	5.8	10.6	436	521	5.5	10.9	311	737	3.6	11.2	367	812	4.0	11.1	382	698	4.0	10.3	380	627	4.6	11.5
Borden	464	831	5.1	9.7	483	587	5.7	10.1	521	623	6.3	12.4	517	687	6.8	12.1	523	826	7.1	12.8	515	818	6.9	12.3	572	659	7.9	12.8	506	776	6.7	12.5	538	851	6.6	12.5	518	800	6.1	11.0	517	717	5.5	10.3	499	476	5.5	9.7	516	721	6.3	11.1
Bosque	414	738	4.3	10.8	386	503	4.3	10.8	370	529	4.4	11.1	363	542	4.6	11.2	383	711	5.2	11.6	391	672	5.5	11.7	457	457	6.4	11.7	454	567	6.0	10.9	451	624	5.6	11.1	350	736	4.0	11.2	379	796	4.0	11.1	387	704	4.0	10.3	400	632	4.9	12.0
Bowie	373	687	3.9	10.7	367	458	4.0	11.1	347	531	4.1	12.1	338	471	4.3	12.1	348	590	4.6	13.0	347	611	4.7	12.5	403	564	5.6	13.5	418	448	5.4	12.7	409	724	4.9	12.2	350	658	4.0	11.6	376	804	3.8	11.2	344	719	3.4	10.8	368	606	4.4	10.9
Brazoria	318	622	3.3	10.7	303	600	3.3	10.8	311	502	3.6	10.1	308	516	3.9	11.2	321	623	4.3	11.3	340	416	4.8	11.2	374	601	5.3	11.0	359	496	4.8	10.7	387	351	4.8	10.9	334	786	3.9	11.1	339	741	3.8	11.1	299	660	3.2	11.0	333	576	4.1	11.2
Brazos	362	714	3.8	10.9	340	513	3.7	10.9	326	531	3.9	11.0	319	501	4.0	11.4	340	674	4.6	11.7	359	553	5.0	11.6	410	455	5.8	11.7	407	482	5.4	11.3	409	491	5.1	11.3	330	718	3.8	11.3	358	777	3.9	11.2	340	680	3.5	10.8	358	591	4.4	11.9
Brewster	567	935	6.0	11.2	539	932	6.3	11.2	591	935	7.0	11.9	516	990	6.8	12.3	572	1009	7.8	12.3	537	949	7.3	12.9	600	645	8.2	12.3	549	982	7.3	12.4	610	982	7.7	12.2	503	893	5.8	11.5	471	940	5.1	11.3	536	899	5.5	11.3	550	924	6.7	10.7
Briscoe	479	765	5.0	10.1	481	782	5.4	10.2	480	560	5.8	10.5	478	676	6.3	10.7	498	749	6.9	10.9	474	663	6.6	11.1	526	705	7.4	10.7	502	843	6.7	10.9	555	892	7.0	11.0	427	842	4.8	10.8	460	725	4.9	10.7	469	636	4.9	10.5	486	736	6.0	11.3
Brooks	333	648	3.5	11.1	326	419	3.5	10.9	312	630	3.7	11.2	323	523	4.1	11.5	355	578	4.8	11.8	388	345	5.4	11.6	441	397	6.2	11.4	420	489	5.5	11.6	421	407	5.3	11.1	351	761	4.1	11.2	334	649	3.6	11.0	319	511	3.4	11.1	361	530	4.4	11.0
Brown	450	779	4.7	11.0	427	590	4.9	10.9	425	533	5.1	11.0	406	643	5.3	11.0	442	796	6.1	11.4	424	767	6.0	11.5	520	471	7.3	11.4	498	615	6.6	10.1	507	755	6.4	10.5	369	770	4.3	11.3	393	808	4.2	11.3	417	741	4.4	10.0	440	689	5.4	11.1
Burleson	370	739	3.9	10.9	343	493	3.8	10.9	324	534	3.8	10.9	315	506	4.0	11.2	339	696	4.6	11.5	364	581	5.1	11.5	416	416	5.8	11.4	414	503	5.4	11.1	412	477	5.2	11.1	321	723	3.7	11.2	358	792	3.9	11.1	349	690	3.6	10.7	361	596	4.4	10.9
Burnet	402	804	4.2	10.9	367	464	4.1	10.8	340	540	4.1	10.8	326	552	4.1	10.9	357	766	4.8	11.1	382	692	5.4	11.3	447	361	6.3	10.9	441	574	5.8	10.5	434	530	5.5	10.8	311	743	3.6	11.1	368	837	4.0	11.1	383	723	4.0	10.3	380	632	4.7	10.9
Caldwell	383	815	4.0	11.0	351	441	3.9	10.7	315	543	3.8	10.8	301	509	3.7	10.9	333	755	4.4	11.0	372	664	5.2	11.2	423	326	5.9	10.7	425	554	5.6	10.8	414	448	5.2	11.0	293	729	3.4	11.1	363	851	4.0	11.1	371	733	3.8	10.6	362	614	4.4	11.3
Calhoun	330	662	3.5	11.1	324	489	3.6	11.0	311	553	3.7	11.0	311	567	3.9	11.5	340	634	4.6	11.7	367	405	5.1	11.6	424	402	5.9	11.5	413	410	5.4	11.3	425	387	5.3	11.2	342	748	4.0	11.3	349	726	3.8	11.3	328	609	3.4	11.1	356	549	4.4	11.2
Callahan	466	789	4.9	11.2	470	628	5.5	10.9	464	543	5.5	11.0	430	568	5.6	10.8	473	798	6.6	11.4	447	797	6.4	11.4	536	496	7.5	11.4	530	677	7.1	10.8	541	781	6.9	11.2	372	798	4.3	11.3	423	828	4.5	11.6	438	829	4.6	11.2	466	711	5.8	12.0
Cameron	271	841	3.0	11.2	269	788	2.9	11.6	322	704	3.6	11.7	273	545	3.5	12.5	320	359	4.3	13.6	382	250	5.0	12.5	408	705	5.3	12.4	401	175	5.1	12.6	413	116	4.9	11.7	399	230	4.4	11.3	304	220	3.4	11.4	260	170	2.8	11.0	335	425	4.0	12.3
Camp	356	694	3.7	10.9	370	409	4.0	11.4	340	544	3.9	12.6	317	499	4.0	12.5	333	580	4.4	13.5	328	607	4.4	12.8	396	586	5.4	14.2	411	403	5.3	13.4	398	801	4.8	12.7	332	651	3.8	11.8	375	796	3.7	11.4	332	707	3.3	11.0	357	606	4.2	10.6
Carson	478	755	5.0	10.1	482	811	5.4	10.1	476	547	5.8	10.3	479	677	6.4	10.6	498	737	6.9	10.7	473	630	6.6	10.9	520	725	7.3	10.4	499	855	6.6	10.8	559	903	7.0	10.8	419	851	4.7	10.8	460	712	4.9	10.7	466	635	4.9	10.6	484	737	6.0	12.2
Cass	361	695	3.8	10.8	366	440	3.9	11.3	341	541	4.0	12.4	326	480	4.1	12.3	339	593	4.5	13.3	337	602	4.5	12.7	397	563	5.5	13.9	412	414	5.3	13.1	401	746	4.8	12.5	340	650	3.9	11.7	376	802	3.8	11.3	336	712	3.3	10.9	361	603	4.3	10.6
Castro	480	766	5.0	10.1	488	826	5.5	10.1	485	559	5.9	10.4	484	695	6.4	10.6	506	755	7.0	10.7	478	634	6.7	11.0	525	731	7.4	10.5	501	862	6.7	10.9	565	918	7.1	10.9	425	859	4.8	10.8	467	707	5.0	10.7	471	623	5.0	10.6	490	745	6.0	11.0
Chambers	313	631	3.3	10.7	298	630	3.2	10.8	308	499	3.6	10.2	309	487	3.9	11.2	318	635	4.3	11.4	337	420	4.7	11.3	364	600	5.2	11.2	351	478	4.7	10.8	380	334	4.8	11.0	336	768	3.9	11.1	341	761	3.8	11.1	294	676	3.1	11.0	329	577	4.0	12.4
Cherokee	347	700	3.6	11.0	365	408	3.9	11.5	335	549	3.8	12.6	309	502	3.9	12.5	327	586	4.4	13.6	323	596	4.3	12.9	391	581	5.4	14.2	405	383	5.2	13.5	394	792	4.7	12.7	325	647	3.7	11.8	373	795	3.7	11.4	325	702	3.2	11.1	352	603	4.2	10.9
Childress	478	749	4.9	10.3	460	656	5.2	10.4	463	557	5.6	11.0	459	611	6.0	11.0	475	707	6.5	11.4	459	741	6.4	11.5	517	647	7.2	11.4	503	786	6.7	11.1	527	826	6.6	11.1	425	788	4.9	11.0	436	782	4.6	10.8	455	697	4.7	10.4	472	712	5.8	10.8
Clay	469	644	4.7	10.3	411	492	4.5	10.3	422	457	5.1	10.8	417	477	5.4	10.8	428	563	5.8	11.2	420	759	5.9	11.2	478	627	6.7	11.4	480	730	6.4	10.7	472	758	5.8	10.8	414	771	4.8	11.0	386	833	4.0	10.8	412	779	4.2	10.3	435	658	5.3	11.2
Cochran	499	844	5.3	10.3	496	728	5.7	10.5	517	678	6.2	11.4	502	737	6.7	11.5	532	839	7.2	11.8	505	801	7.0	11.8	557	682	7.7	11.7	516	854	6.9	11.6	564	897	7.1	11.6	477	814	5.5	11.1	479	760	5.1	10.8	500	582	5.2	10.5	513	768	6.3	11.2
Coke	467	806	5.0	10.6	458	624	5.3	10.7	474	583	5.7	11.5	457	688	6.0	11.5	484	830	6.6	11.9	465	796	6.5	11.9	551	524	7.7	12.0	511	682	6.8	11.0	532	808	6.7	11.3	431	787	5.0	11.2	443	780	4.7	11.0	457	673	4.9	10.0	479	715	5.9	10.9
Coleman	458	793	4.8	11.0	437	612	5.1	10.9	438	534	5.2	11.0	416	658	5.4	11.0	456	815	6.3	11.4	432	796	6.1	11.4	533	475	7.5	11.4	509	621	6.8	10.0	521	783	6.6	10.5	372	768	4.3	11.4	397	823	4.2	11.4	424	765	4.5	10.0	450	704	5.6	11.3
Collin	415	664	4.2	10.5	378	462	4.1	10.7	372	477	4.4	11.3	369	459	4.7	11.4	378	570	5.1	12.0	378	674	5.2	11.8	433	585	6.1	12.3	442	577	5.8	11.5	432	697	5.3	11.3	377	710	4.3	11.2	374	821	3.8	10.9	372	741	3.7	10.5	394	620	4.7	10.9
Collingsworth	478	740	4.9	10.2	461	669	5.2	10.3	460	555	5.5	10.9	462	606	6.1	10.9	474	690	6.5	11.3	459	724	6.4	11.4	512	667	7.2	11.3	501	802	6.6	11.0	527	831	6.5	11.0	426	787	4.9	10.9	437	775	4.6	10.7	457	688	4.7	10.4	472	711	5.8	11.2
Colorado	353	707	3.7	10.9	336	520	3.7	10.9	321	542	3.8	10.9	317	525	4.0	11.3	339	679	4.6	11.6	364	512	5.1	11.6	414	437	5.8	11.4	407	482	5.3	11.1	414	436	5.2	11.2	329	737	3.8	11.2	358	760	3.9	11.1	340	659	3.6	10.8	358	583	4.4	11.0
Comal	394	784	4.1	11.0	365	473	4.1	10.8	336	564	4.0	10.9	324	564	4.1	11.1	353	758	4.7	11.2	381	633	5.4	11.5	445	352	6.3	11.0	439	552	5.8	10.8	433	506	5.5	11.0	314	743	3.6	11.2	367	787	4.0	11.1	378	674	3.9	10.5	378	616	4.6	11.0
Comanche	443	763	4.6	10.9	419	563	4.8	10.8	414	532	4.9	11.0	396	609	5.1	11.0	427	766	5.9	11.4	417	738	5.9	11.5	504	476	7.1	11.4	487	619	6.5	10.5	493	721	6.2	10.8	366	774	4.3	11.3	393	799	4.2	11.3	411	728	4.3	10.3	431	674	5.3	10.5
Concho	450	814	4.7	10.9	396	609	4.5	10.9	409	498	4.9	10.8	399	788	5.1	11.1	443	852	6.1	11.2	414	837	5.9	11.3	538	453	7.5	11.3	491	528	6.5	8.3	506	807	6.4	9.1	361	715	4.2	11.4	353	857	3.8	11.4	402	740	4.3	8.2	431	708	5.3	10.9
Cooke	449	609	4.5	10.2	382	442	4.1	10.3	391	423	4.7	10.9	393	413	5.1	10.9	398	507	5.3	11.4	397	719	5.6	11.3	446	624	6.3	11.6	456	668	6.0	10.9	439	714	5.4	10.8	407	742	4.7	11.0	371	835	3.8	10.7	386	771	3.9	10.3	410	622	4.9	11.0
Coryell	410	771	4.3	10.9	377	496	4.2	10.8	359	536	4.3	11.0	346	553	4.4	11.1	374	751	5.0	11.3	387	684	5.4	11.5	456	403	6.4	11.3	447	565	5.9	10.7	444	587	5.6	11.0	334	745	3.9	11.2	375	816	4.0	11.1	385	713	4.0	10.4	392	635	4.8	11.0
Cottle	477	766	5.0	10.4	463	653	5.3	10.5	470	566	5.7	11.1	459	629	6.0	11.1	479	738	6.6	11.5	461	756	6.4	11.6	525	626	7.3	11.5	508	771	6.7	11.1	532	824	6.6	11.2	425	795	4.9	11.1	439	785	4.6	10.9	456	706	4.8	10.4	475	718	5.8	11.7
Crane	526	886	5.6	10.9	514	608	6.0	11.1	556	719	6.6	11.9	517	764	6.8	12.0	557	886	7.6	12.3	525	877	7.2	12.3	593	681	8.1	12.2	538	845	7.2	12.1	588	900	7.4	12.1	499	804	5.8	11.4	480	733	5.1	11.2	522	417	5.4	10.9	536	760	6.6	11.5
Crockett	506	869	5.4	10.7	483	754	5.6	11.0	499	757	6.0	11.6	473	845	6.3	11.9	494	918	6.7	12.2	467	789	6.6	12.5	570	536	7.9	12.2	525	810	6.9	11.6	561	850	6.9	11.6	441	829	5.1	11.5	445	718	4.7	11.2	484	600	5.0	10.4	498	773	6.1	11.1

	Jan				Feb				Mar				Apr				May				Jun				Jul				Aug				Sep				Oct				Nov				Dec				Annual			
County	α	β	γ	τ	α	β	γ	τ	α	β	γ	τ	α	β	γ	τ	α	β	γ	τ	α	β	γ	τ	α	β	γ	τ	α	β	γ	τ	α	β	γ	τ	α	β	γ	τ	α	β	γ	τ	α	β	γ	τ	α	β	γ	τ
Crosby	480	803	5.1	10.2	479	688	5.5	10.4	494	605	6.0	11.4	485	681	6.4	11.4	505	791	6.9	11.8	486	762	6.7	11.7	546	655	7.6	11.7	510	804	6.8	11.5	547	857	6.8	11.5	456	810	5.3	11.0	470	752	5.0	10.7	479	614	5.1	10.3	496	735	6.1	11.8
Culberson	558	951	5.9	11.2	539	907	6.3	11.3	592	916	7.1	12.0	537	959	7.2	12.1	603	985	8.2	12.3	557	927	7.6	12.4	590	610	8.1	12.4	553	984	7.5	12.2	614	961	7.8	12.2	529	810	6.2	11.3	487	931	5.3	11.3	547	862	5.6	11.2	559	900	6.9	10.8
Dallam	490	788	5.1	10.1	490	797	5.5	10.3	488	620	5.9	10.7	490	686	6.5	10.9	512	767	7.0	11.1	487	708	6.8	11.3	529	717	7.4	11.0	506	864	6.8	11.1	557	895	7.0	11.1	445	820	5.1	10.9	467	746	5.0	10.7	485	640	5.0	10.5	496	754	6.1	11.3
Dallas	408	691	4.2	10.6	378	479	4.1	10.8	369	495	4.4	11.4	364	484	4.7	11.4	376	611	5.1	12.0	378	666	5.2	11.8	436	557	6.1	12.3	442	559	5.8	11.5	435	678	5.3	11.4	367	710	4.2	11.3	377	815	3.9	11.0	372	729	3.8	10.5	392	623	4.7	11.5
Dawson	473	847	5.1	9.8	487	544	5.7	10.2	525	630	6.4	12.3	517	681	6.8	12.1	529	830	7.1	12.7	516	838	6.9	12.3	573	709	7.9	12.7	509	792	6.8	12.4	544	866	6.7	12.4	517	797	6.1	11.0	513	688	5.4	10.4	503	358	5.5	9.8	519	715	6.4	10.6
Deaf Smith	482	770	5.0	10.1	489	828	5.5	10.2	486	570	5.9	10.4	486	696	6.5	10.6	508	759	7.0	10.7	480	643	6.7	11.0	526	731	7.4	10.5	501	865	6.7	10.9	564	917	7.1	10.9	428	855	4.8	10.8	467	712	5.0	10.7	474	625	5.0	10.6	491	748	6.1	11.7
Delta	390	675	4.0	10.6	372	444	4.0	11.0	357	503	4.2	11.8	348	467	4.4	11.8	358	568	4.8	12.6	357	645	4.9	12.2	414	591	5.8	13.1	427	505	5.6	12.3	416	730	5.0	11.9	360	680	4.1	11.4	374	814	3.8	11.1	354	729	3.5	10.7	378	613	4.5	11.1
Denton	430	662	4.4	10.4	384	473	4.2	10.6	383	466	4.6	11.1	382	461	4.9	11.2	392	576	5.3	11.7	391	696	5.5	11.5	446	583	6.3	11.9	453	617	6.0	11.2	444	692	5.4	11.1	386	728	4.5	11.1	377	822	3.9	10.9	383	747	3.9	10.4	405	627	4.9	11.2
DeWitt	354	697	3.7	11.1	341	476	3.8	10.9	319	561	3.8	11.0	316	567	4.0	11.4	345	684	4.6	11.6	372	479	5.2	11.6	432	366	6.1	11.4	424	459	5.6	11.1	428	437	5.4	11.2	331	755	3.8	11.2	357	747	3.9	11.2	348	634	3.6	10.9	364	572	4.5	11.1
Dickens	477	793	5.0	10.4	472	666	5.4	10.5	484	588	5.8	11.3	471	657	6.2	11.3	493	779	6.8	11.7	474	769	6.6	11.7	540	623	7.5	11.7	511	776	6.8	11.3	541	836	6.8	11.4	440	801	5.1	11.1	456	773	4.8	10.9	468	667	4.9	10.4	487	727	6.0	11.9
Dimmit	457	530	4.4	11.0	442	568	4.7	10.9	400	804	4.8	11.9	407	678	5.2	12.3	396	808	5.3	12.5	422	297	5.9	13.5	488	251	7.1	13.0	484	545	6.5	12.3	462	705	6.0	12.1	386	849	4.5	11.3	406	311	4.2	10.9	423	274	4.3	10.7	433	552	5.2	10.7
Donley	478	757	5.0	10.2	474	747	5.3	10.2	472	559	5.7	10.6	473	652	6.2	10.8	489	728	6.7	11.0	469	680	6.6	11.2	520	693	7.3	10.9	501	829	6.7	10.9	546	871	6.8	11.0	425	822	4.8	10.9	452	741	4.8	10.7	464	653	4.8	10.5	481	728	5.9	11.5
Duval	367	548	3.6	11.2	365	444	3.9	11.0	335	666	4.0	11.5	344	594	4.3	11.8	360	665	4.9	12.0	398	286	5.5	12.3	450	293	6.4	12.0	440	432	5.8	11.8	432	504	5.6	11.6	360	812	4.2	11.2	364	539	3.9	11.1	356	437	3.7	11.1	381	518	4.6	11.1
Eastland	455	776	4.8	10.9	443	596	5.1	10.8	439	535	5.2	11.0	416	592	5.4	11.0	450	769	6.2	11.4	432	772	6.1	11.4	519	506	7.3	11.4	507	656	6.7	10.7	517	752	6.5	10.9	374	779	4.3	11.3	408	819	4.3	11.3	426	776	4.5	10.6	449	694	5.5	11.7
Ector	512	860	5.5	10.6	508	463	5.9	10.9	549	634	6.6	12.1	519	670	6.9	12.0	554	836	7.5	12.4	525	861	7.1	12.3	586	751	8.1	12.4	532	790	7.1	12.2	577	872	7.2	12.2	508	787	5.9	11.3	491	644	5.2	11.0	520	205	5.5	10.6	533	698	6.5	11.4
Edwards	482	806	5.1	10.6	440	730	5.0	11.0	420	685	5.1	11.4	420	810	5.8	11.8	418	876	5.7	12.2	387	588	5.8	12.8	528	426	7.5	12.5	513	677	6.5	10.9	526	703	6.4	11.0	381	789	4.4	11.6	405	484	4.2	11.2	444	442	4.5	9.7	453	668	5.5	11.7
El Paso	544	975	6.2	9.4	552	929	6.4	9.9	579	918	7.2	12.8	551	989	7.7	12.4	629	959	8.3	13.2	590	899	8.2	12.6	517	891	7.1	13.3	511	909	7.0	13.1	600	823	7.2	13.0	509	827	6.7	10.9	493	824	6.0	10.0	505	945	5.4	9.4	549	907	6.9	11.4
Ellis	400	699	4.1	10.7	376	478	4.1	10.9	361	519	4.3	11.5	355	499	4.5	11.5	369	643	4.9	12.1	374	642	5.2	11.9	433	513	6.1	12.3	438	529	5.7	11.6	431	655	5.3	11.5	356	710	4.1	11.3	376	795	3.9	11.1	369	705	3.8	10.5	387	616	4.7	11.0
Erath	439	754	4.6	10.8	414	549	4.7	10.7	407	527	4.9	11.0	393	585	5.1	11.1	419	729	5.7	11.5	413	732	5.8	11.5	492	505	6.9	11.5	481	631	6.4	10.7	486	703	6.1	10.9	368	763	4.3	11.2	392	811	4.1	11.2	409	738	4.2	10.3	427	669	5.2	11.2
Falls	387	743	4.0	10.9	360	477	4.0	10.8	340	530	4.1	11.1	331	510	4.2	11.2	354	703	4.8	11.5	372	624	5.2	11.6	431	419	6.1	11.5	428	523	5.6	11.1	423	543	5.3	11.2	330	728	3.8	11.2	369	805	3.9	11.1	365	703	3.8	10.6	375	609	4.6	11.3
Fannin	415	645	4.2	10.4	375	445	4.0	10.7	370	470	4.4	11.4	368	439	4.7	11.4	374	537	5.0	12.1	374	673	5.2	11.8	425	606	6.0	12.4	438	576	5.7	11.7	425	712	5.1	11.4	381	703	4.4	11.2	372	825	3.8	10.9	368	749	3.7	10.5	391	615	4.7	11.1
Fayette	370	757	3.9	11.0	346	483	3.8	10.8	321	546	3.8	10.9	313	521	3.9	11.2	339	716	4.6	11.4	370	585	5.2	11.5	422	382	5.9	11.2	419	513	5.5	11.0	417	455	5.3	11.1	315	730	3.6	11.2	362	798	3.9	11.1	357	690	3.7	10.7	363	598	4.4	11.3
Fisher	471	795	5.0	10.7	472	633	5.5	10.7	479	573	5.7	11.4	456	616	6.0	11.2	486	804	6.7	11.8	466	795	6.5	11.7	545	536	7.6	11.8	522	710	7.0	11.2	540	802	6.8	11.5	416	797	4.8	11.2	446	798	4.7	11.2	457	743	4.9	10.7	480	717	5.9	10.9
Floyd	480	782	5.0	10.2	480	742	5.5	10.3	485	583	5.9	10.9	480	677	6.3	11.0	500	767	6.9	11.3	478	709	6.7	11.4	534	681	7.5	11.1	506	827	6.7	11.1	551	877	6.9	11.2	439	826	5.0	10.9	463	740	4.9	10.8	474	628	5.0	10.4	490	737	6.0	11.0
Foard	474	751	4.9	10.5	455	618	5.2	10.5	460	549	5.5	11.1	447	596	5.8	11.1	468	718	6.4	11.5	452	767	6.3	11.5	519	602	7.3	11.6	507	747	6.7	11.0	522	800	6.5	11.1	415	784	4.8	11.1	427	802	4.5	11.0	446	737	4.6	10.5	467	706	5.7	11.0
Fort Bend	325	636	3.4	10.8	309	586	3.3	10.8	313	508	3.7	10.3	309	514	3.9	11.2	324	632	4.4	11.4	343	435	4.8	11.3	381	573	5.4	11.1	368	491	4.9	10.8	391	371	4.9	10.9	334	775	3.9	11.1	342	745	3.8	11.1	306	660	3.2	10.9	337	577	4.1	12.1
Franklin	366	689	3.8	10.8	370	425	4.0	11.2	346	532	4.0	12.3	328	489	4.1	12.3	342	579	4.6	13.2	338	617	4.6	12.6	402	584	5.6	13.8	416	436	5.4	13.0	405	772	4.9	12.4	341	660	3.9	11.7	375	801	3.8	11.3	339	714	3.4	10.9	364	608	4.3	11.7
Freestone	373	703	3.9	10.8	364	472	4.0	11.1	343	536	4.0	11.7	334	495	4.2	11.8	349	639	4.7	12.5	355	595	4.9	12.2	413	506	5.8	12.8	419	468	5.5	12.1	414	640	5.1	11.8	341	693	3.9	11.5	373	798	3.9	11.2	349	707	3.5	10.8	369	604	4.4	11.5
Frio	422	631	4.2	11.0	405	548	4.4	10.9	375	695	4.5	11.5	377	659	4.9	11.8	385	766	5.2	12.1	404	414	5.7	12.6	478	322	6.9	12.2	467	533	6.2	11.6	461	615	5.9	11.5	367	803	4.2	11.3	386	504	4.1	11.1	398	430	4.1	10.6	412	577	5.0	11.5
Gaines	500	865	5.3	10.4	499	601	5.8	10.6	534	678	6.4	11.9	513	725	6.8	11.9	543	856	7.4	12.3	517	851	7.1	12.2	574	695	7.9	12.3	522	827	7.0	12.1	565	885	7.1	12.1	502	798	5.8	11.1	492	721	5.2	10.8	510	420	5.4	10.4	524	744	6.4	10.9
Galveston	312	613	3.3	10.7	297	620	3.2	10.7	309	493	3.6	10.0	306	508	3.8	11.1	316	622	4.3	11.2	335	408	4.7	11.2	365	629	5.2	11.0	349	501	4.6	10.6	381	332	4.8	10.8	333	795	3.9	11.1	337	750	3.8	11.0	293	671	3.1	11.0	328	579	4.0	11.3
Garza	475	820	5.1	10.1	480	641	5.6	10.3	505	615	6.1	11.8	495	688	6.5	11.7	511	810	7.0	12.2	496	797	6.8	12.0	557	645	7.7	12.3	511	785	6.8	11.9	543	845	6.7	12.0	479	801	5.6	11.0	485	750	5.1	10.6	485	583	5.2	10.0	503	732	6.2	10.9
Gillespie	424	787	4.4	10.9	386	554	4.4	10.9	374	561	4.5	11.0	366	681	4.7	11.2	396	804	5.4	11.4	396	691	5.6	11.6	491	400	6.9	11.4	467	552	6.1	9.9	472	650	5.9	10.3	342	740	4.0	11.3	366	767	3.9	11.2	393	659	4.1	9.5	407	654	5.0	11.6
Glasscock	461	842	5.0	9.6	484	512	5.7	10.1	526	626	6.4	12.6	525	683	6.9	12.3	527	836	7.1	13.0	522	833	6.9	12.5	578	693	8.0	13.1	505	765	6.7	12.8	536	853	6.6	12.8	533	795	6.3	10.9	528	665	5.6	10.1	505	320	5.5	9.6	521	702	6.4	11.3
Goliad	330	645	3.5	11.2	327	439	3.6	11.0	306	542	3.7	11.1	309	589	3.9	11.4	341	640	4.6	11.6	369	397	5.2	11.5	433	352	6.1	11.4	422	402	5.5	11.2	432	393	5.5	11.2	338	783	3.9	11.3	351	751	3.8	11.4	334	624	3.5	11.2	358	547	4.4	11.1
Gonzales	372	753	3.9	11.0	349	473	3.9	10.8	321	560	3.8	11.0	314	545	3.9	11.2	342	723	4.6	11.3	374	569	5.2	11.5	430	353	6.0	11.1	426	508	5.6	11.0	423	457	5.3	11.1	316	741	3.6	11.2	362	785	3.9	11.1	361	673	3.7	10.7	366	595	4.5	10.7
Gray	478	752	4.9	10.1	473	745	5.3	10.2	469	559	5.7	10.6	472	646	6.2	10.8	487	717	6.7	11.0	468	678	6.6	11.2	516	698	7.2	10.9	500	832	6.7	10.9	544	867	6.8	10.9	424	817	4.8	10.9	450	743	4.8	10.7	464	657	4.8	10.5	479	726	5.9	11.0
Grayson	436	617	4.4	10.2	377	438	4.1	10.4	382	437	4.6	11.1	383	416	4.9	11.1	387	510	5.2	11.6	387	701	5.4	11.5	436	620	6.1	11.9	448	635	5.9	11.2	431	710	5.2	11.0	398	727	4.6	11.0	369	833	3.8	10.8	378	765	3.8	10.3	402	617	4.8	12.6
Gregg	344	699	3.6	11.0	372	375	4.0	11.6	336	553	3.8	12.9	304	515	3.8	12.7	323	569	4.3	13.9	315	606	4.2	13.1	390	605	5.3	14.7	406	370	5.2	13.8	392	855	4.7	13.0	321	642	3.6	11.9	375	792	3.7	11.5	324	701	3.2	11.2	350	607	4.1	11.3
Grimes	351	693	3.7	10.9	331	537	3.6	10.9	323	527	3.8	10.9	318	496	4.0	11.4	336	659	4.5	11.8	353	520	4.9	11.7	400	490	5.6	11.7	396	469	5.2	11.3	402	472	5.0	11.3	334	721	3.9	11.3	355	768	3.8	11.2	329	674	3.4	10.8	353	585	4.3	11.0
Guadalupe	385	775	4.0	11.0	358	466	4.0	10.8	328	562	3.9	10.9	317	547	4.0	11.1	346	743	4.6	11.2	378	608	5.3	11.4	437	343	6.2	11.0	433	535	5.7	10.9	427	477	5.4	11.1	312	741	3.6	11.1	365	792	4.0	11.1	372	680	3.9	10.6	372	606	4.5	10.8
Hale	483	785	5.1	10.1	487	775	5.5	10.3	492	589	5.9	10.8	488	697	6.5	11.0	509	774	7.0	11.2	484	693	6.8	11.3	535	708	7.5	11.0	506	846	6.7	11.1	559	899	7.0	11.2	442	838	5.0	10.9	469	726	5.0	10.7	478	615	5.0	10.5	495	745	6.1	10.9
Hall	478	764	5.0	10.2	471	713	5.3	10.3	473	567	5.7	10.8	470	645	6.2	10.9	488	735	6.7	11.2	468	712	6.5	11.3	524	669	7.3	11.1	504	812	6.7	11.0	541	856	6.8	11.1	429	810	4.9	10.9	450	756	4.8	10.8	464	661	4.8	10.4	480	725	5.9	11.0
Hamilton	427	758	4.4	10.8	397	524	4.5	10.8	386	538	4.6	11.0	372	591	4.8	11.1	399	749	5.4	11.4	401	705	5.7	11.5	479	449	6.7	11.4	467	595	6.2	10.6	468	659	5.9	10.8	352	759	4.1	11.2	382	799	4.1	11.2	398	710	4.1	10.2	411	653	5.0	10.7
Hansford	482	763	5.0	10.1	477	758	5.3	10.2	472	581	5.7	10.7	478	655	6.3	10.8	493	726	6.7	11.0	474	689	6.6	11.2	517	705	7.2	10.9	502	845	6.7	11.0	547	864	6.8	11.0	430	810	4.9	10.8	453	748	4.8	10.7	470	658	4.9	10.4	483	733	5.9	11.0
Hardeman	476	733	4.9	10.4	450	611	5.1	10.5	456	540	5.5	11.0	448	585	5.9	11.0	464	687	6.3	11.5	450	759	6.3	11.5	511	625	7.2	11.5	502	762	6.7	11.0	517	799	6.4	11.1	419	781	4.8	11.0	423	803	4.4	10.9	445	735	4.6	10.4	464	702	5.7	11.6
Hardin	324	732	3.4	10.8	301	677	3.3	11.1	305	534	3.6	11.3	325	369	4.0	11.8	330	707	4.3	12.4	346	487	4.7	12.0	360	440	5.1	12.5	365	343	4.8	12.0	378	355	4.7	11.7	353	616	4.1	11.4	361	820	3.9	11.2	302	704	3.2	11.0	338	565	4.1	10.9
Harris	318	619	3.3	10.7	303	602	3.2	10.8	311	497	3.6	10.1	307	515	3.8	11.1	319	623	4.3	11.3	338	421	4.8	11.2	372	615	5.3	11.0	356	504	4.7	10.6	385	355	4.8	10.9	332	793	3.9	11.1	339	748	3.8	11.1	298	669	3.2	11.0	332	580	4.1	12.4
Harrison	349	702	3.7	10.9	366	416	3.9	11.4	336	549	3.9	12.6	313	492	3.9	12.5	330	586	4.4	13.6	326	599	4.4	12.9	392	576	5.4	14.3	406	382	5.2	13.4	395	784	4.7	12.7	330	639	3.7	11.8	375	799	3.7	11.4	327	705	3.2	11.1	354	602	4.2	10.7
Hartley	486	781	5.1	10.1	490	811	5.5	10.2	487	598	5.9	10.6	488	690	6.5	10.8	510	764	7.0	10.9	484	679	6.8	11.2	528	723	7.4	10.8	504	864	6.7	11.0	560	905	7.0	11.0	438	836	5.0	10.8	467	731	5.0	10.7	480	633	5.0	10.5	494	751	6.1	11.2
Haskell	469	777	4.9	10.9	467	624	5.4	10.8	465	553	5.6	11.1	439	580	5.7	10.9	473	778	6.6	11.5	451	785	6.4	11.5	533	525	7.5	11.5	523	699	7.0	11.0	535	790	6.8	11.2	390	794	4.5	11.3	428	810	4.5	11.3	444	785	4.7	11.0	469	708	5.8	10.9
Hays	390	827	4.1	11.0	354	433	4.0	10.7	318	541	3.8	10.8	302	511	3.8	10.8	334	764	4.5	10.9	374	687	5.3	11.2	426	323	6.0	10.6	428	568	5.6	10.7	416	457	5.3	11.0	290	730	3.3	11.1	364	860	4.0	11.0	376	739	3.9	10.6	365	620	4.5	10.8
Hemphill	480	727	4.9	10.1	459	664	5.1	10.3	453	560	5.5	10.9	464	591	6.1	11.0	468	658	6.3	11.3	458	719	6.4	11.4	501	689	7.0	11.4	500	814	6.6	11.0	523	815	6.5	11.0	426	767	4.8	10.9	433	784	4.5	10.6	457	701	4.6	10.3	469	707	5.7	12.1

County	Jan				Feb				Mar				Apr				May				Jun				Jul				Aug				Sep				Oct				Nov				Dec				Annual			
	α	β	γ	τ	α	β	γ	τ	α	β	γ	τ	α	β	γ	τ	α	β	γ	τ	α	β	γ	τ	α	β	γ	τ	α	β	γ	τ	α	β	γ	τ	α	β	γ	τ	α	β	γ	τ	α	β	γ	τ	α	β	γ	τ
Henderson	364	697	3.8	10.9	368	431	3.8	11.3	343	540	4.0	12.3	325	499	4.1	12.2	340	602	4.5	13.1	339	606	4.6	12.6	404	558	5.6	13.6	415	430	5.4	12.9	405	743	4.9	12.3	336	668	3.8	11.7	375	795	3.8	11.3	339	703	3.4	10.9	363	606	4.3	10.9
Hidalgo	320	702	3.4	11.0	306	320	3.4	10.8	294	611	3.4	10.8	319	437	4.0	10.9	361	531	4.8	11.3	386	409	5.4	11.0	441	442	6.1	10.6	406	632	5.2	11.2	409	391	5.2	10.6	336	811	4.0	11.0	309	796	3.4	10.8	297	608	3.2	11.0	349	558	4.3	11.3
Hill	403	720	4.2	10.7	377	491	4.2	10.8	361	526	4.3	11.3	355	516	4.5	11.4	372	681	5.0	11.8	381	648	5.3	11.8	442	475	6.2	12.0	443	542	5.8	11.3	438	621	5.4	11.3	350	722	4.0	11.3	377	794	4.0	11.1	375	701	3.9	10.5	390	620	4.7	11.2
Hockley	491	828	5.2	10.2	491	711	5.6	10.4	510	645	6.2	11.4	498	717	6.6	11.4	523	820	7.1	11.7	499	780	6.9	11.7	553	686	7.7	11.7	513	839	6.8	11.6	558	890	7.0	11.6	471	818	5.4	11.0	479	743	5.1	10.8	492	566	5.2	10.4	507	754	6.2	11.0
Hood	431	734	4.5	10.7	402	526	4.5	10.7	395	512	4.7	11.0	385	551	5.0	11.1	406	690	5.5	11.5	403	711	5.7	11.5	475	521	6.7	11.6	469	618	6.2	10.8	471	682	5.9	11.0	368	749	4.3	11.2	387	811	4.1	11.1	399	732	4.1	10.3	417	653	5.1	12.0
Hopkins	375	687	3.9	10.7	371	433	4.0	11.1	350	521	4.1	12.1	335	483	4.2	12.1	348	578	4.6	13.0	346	629	4.7	12.4	407	586	5.6	13.5	420	462	5.4	12.7	410	753	4.9	12.2	348	668	4.0	11.6	375	807	3.8	11.2	345	719	3.4	10.8	369	611	4.4	11.9
Houston	351	700	3.7	10.9	348	485	3.8	11.2	330	538	3.8	11.9	318	481	4.0	12.0	335	625	4.5	12.7	340	564	4.6	12.3	394	527	5.5	13.1	401	417	5.2	12.4	398	629	4.9	12.0	335	669	3.8	11.6	365	792	3.8	11.3	327	697	3.3	11.0	354	594	4.2	11.6
Howard	454	834	5.0	9.3	484	538	5.7	9.9	530	621	6.5	12.8	533	680	7.0	12.4	530	830	7.1	13.2	529	825	7.0	12.5	580	674	8.0	13.3	501	764	6.7	13.0	532	852	6.5	13.0	547	797	6.5	10.9	542	685	5.7	10.0	509	385	5.6	9.4	524	707	6.4	11.7
Hudspeth	549	945	6.0	10.3	543	902	6.3	10.6	580	903	7.0	12.3	537	946	7.3	12.3	605	966	8.1	12.7	565	904	7.8	12.6	554	754	7.6	12.8	530	933	7.2	12.6	600	896	7.4	12.5	517	827	6.3	11.1	490	861	5.6	10.6	527	860	5.5	10.4	551	891	6.8	11.6
Hunt	394	678	4.0	10.6	373	451	4.0	10.9	360	500	4.2	11.7	352	471	4.5	11.7	362	577	4.8	12.5	362	650	5.0	12.1	419	583	5.8	12.9	430	518	5.6	12.1	420	717	5.1	11.7	362	688	4.1	11.4	375	814	3.8	11.1	358	729	3.6	10.6	381	615	4.6	10.6
Hutchinson	480	760	5.0	10.1	480	785	5.4	10.2	475	563	5.7	10.5	479	667	6.3	10.7	496	733	6.8	10.9	473	659	6.6	11.1	519	714	7.3	10.7	500	850	6.7	10.9	553	885	6.9	10.9	425	832	4.8	10.8	457	729	4.9	10.7	468	645	4.9	10.5	484	735	5.9	11.3
Irion	477	833	5.1	10.5	462	650	5.3	10.7	482	646	5.8	11.7	467	766	6.2	11.8	488	867	6.6	12.1	468	794	6.5	12.1	559	544	7.8	12.2	511	719	6.7	11.2	538	826	6.7	11.4	445	792	5.2	11.3	447	736	4.7	11.0	468	580	5.0	9.8	486	729	6.0	11.0
Jack	453	700	4.6	10.5	417	527	4.7	10.6	418	494	5.0	10.9	408	531	5.3	11.0	426	646	5.8	11.4	418	743	5.9	11.4	487	576	6.8	11.5	483	682	6.4	10.8	483	735	6.0	10.9	392	769	4.5	11.1	393	819	4.1	11.0	412	758	4.2	10.4	433	665	5.3	11.2
Jackson	342	686	3.6	11.0	330	517	3.6	10.9	317	556	3.8	11.0	316	552	4.0	11.4	340	663	4.6	11.7	366	456	5.1	11.6	419	422	5.9	11.5	410	448	5.4	11.2	419	415	5.3	11.2	337	742	3.9	11.2	354	735	3.8	11.2	334	628	3.5	10.9	357	568	4.4	12.0
Jasper	326	797	3.5	10.9	301	717	3.3	11.3	301	555	3.6	12.0	335	284	4.1	12.2	335	750	4.3	13.0	351	530	4.7	12.5	351	351	4.9	13.4	369	251	4.9	12.8	373	360	4.6	12.3	363	512	4.2	11.6	374	872	4.0	11.3	304	735	3.3	11.0	340	559	4.1	11.9
Jeff Davis	569	946	6.0	11.4	544	921	6.3	11.4	604	932	7.2	12.1	534	980	7.1	12.2	603	998	8.2	12.3	558	944	7.6	12.8	595	631	8.1	12.5	557	996	7.5	12.3	618	977	7.8	12.2	534	833	6.2	11.4	487	950	5.3	11.3	552	892	5.6	11.3	563	917	6.9	11.7
Jefferson	318	757	3.4	10.9	292	725	3.2	11.1	299	539	3.6	11.4	329	325	4.0	11.9	330	735	4.3	12.5	348	484	4.7	12.1	351	400	4.9	12.7	358	302	4.8	12.1	373	304	4.7	11.8	358	577	4.2	11.5	364	840	4.0	11.3	297	714	3.2	11.0	335	559	4.1	11.5
Jim Hogg	374	562	3.7	11.1	368	442	3.9	10.9	341	710	4.1	11.5	352	555	4.4	11.8	368	649	5.0	12.1	407	287	5.6	12.4	453	319	6.5	12.0	438	493	5.8	12.0	424	523	5.5	11.5	364	801	4.2	11.1	357	502	3.8	10.9	352	397	3.6	11.0	383	520	4.7	11.3
Jim Wells	315	596	3.3	11.2	320	395	3.5	11.0	297	544	3.6	11.2	305	597	3.9	11.5	341	605	4.6	11.6	371	322	5.2	11.5	436	329	6.1	11.4	422	371	5.5	11.3	433	368	5.5	11.2	344	809	4.0	11.3	347	734	3.7	11.4	326	595	3.4	11.4	355	522	4.4	11.2
Johnson	415	717	4.3	10.7	386	502	4.3	10.7	375	509	4.5	11.2	370	515	4.7	11.3	386	667	5.2	11.7	389	676	5.4	11.7	452	509	6.4	11.9	453	573	6.0	11.1	449	650	5.6	11.1	362	727	4.2	11.2	381	805	4.0	11.0	383	718	3.9	10.4	401	631	4.9	11.2
Jones	468	789	4.9	11.2	476	634	5.6	10.9	471	547	5.6	11.1	436	559	5.7	10.8	478	798	6.7	11.4	452	799	6.4	11.4	539	503	7.5	11.4	534	688	7.1	11.0	545	786	6.9	11.3	376	802	4.4	11.3	430	826	4.6	11.5	443	832	4.7	11.4	471	714	5.8	11.3
Karnes	356	670	3.7	11.1	345	465	3.8	10.9	322	572	3.8	11.1	321	587	4.1	11.4	349	679	4.7	11.6	376	443	5.3	11.7	441	347	6.2	11.4	431	447	5.6	11.2	435	446	5.5	11.2	337	772	3.9	11.3	359	720	3.9	11.3	351	607	3.6	11.0	369	563	4.5	11.7
Kaufman	387	690	4.0	10.7	372	457	4.0	11.0	355	520	4.2	11.8	345	488	4.4	11.8	358	610	4.8	12.5	360	631	5.0	12.2	419	548	5.8	12.9	428	495	5.6	12.1	419	698	5.1	11.8	353	690	4.0	11.4	375	799	3.8	11.1	356	710	3.6	10.7	378	611	4.5	11.0
Kendall	409	769	4.3	10.9	379	521	4.2	10.9	358	579	4.3	11.0	349	624	4.5	11.3	375	774	5.1	11.4	389	628	5.5	11.7	468	378	6.6	11.4	454	552	6.0	10.6	454	577	5.7	10.8	334	748	3.8	11.3	370	738	4.0	11.2	387	633	4.0	10.1	395	627	4.8	11.4
Kenedy	311	688	3.3	11.2	308	478	3.4	11.1	306	609	3.6	11.2	305	537	3.9	11.6	343	535	4.6	12.0	379	338	5.2	11.6	431	452	5.9	11.5	413	409	5.3	11.6	421	329	5.3	11.2	355	670	4.1	11.2	328	622	3.6	11.2	305	494	3.2	11.1	351	513	4.3	11.3
Kent	474	800	5.0	10.4	474	642	5.5	10.5	490	594	5.9	11.6	475	656	6.2	11.5	496	797	6.8	12.0	479	786	6.6	11.9	548	595	7.6	12.0	514	753	6.8	11.5	540	825	6.7	11.6	448	798	5.2	11.1	462	772	4.9	10.8	471	663	5.0	10.3	490	723	6.0	10.9
Kerr	438	781	4.6	10.9	397	599	4.5	10.9	390	584	4.7	11.0	384	732	5.0	11.4	410	823	5.6	11.6	400	677	5.7	11.8	508	410	7.2	11.6	479	563	6.3	9.8	488	689	6.1	10.2	357	747	4.1	11.4	370	713	3.9	11.3	403	614	4.2	9.3	420	661	5.2	10.5
Kimble	447	813	4.7	10.9	388	612	4.4	11.0	397	514	4.7	10.8	391	809	5.0	11.2	432	859	5.9	11.3	404	806	5.8	11.4	533	435	7.5	11.3	485	519	6.4	8.3	500	785	6.3	9.0	355	714	4.1	11.5	346	826	3.7	11.4	397	705	4.2	8.0	424	700	5.2	11.1
King	474	781	5.0	10.6	466	640	5.3	10.6	473	569	5.7	11.2	455	625	6.0	11.2	480	764	6.6	11.6	461	778	6.4	11.6	533	590	7.4	11.7	513	745	6.8	11.2	534	814	6.7	11.3	420	793	4.9	11.1	440	795	4.7	11.0	455	723	4.8	10.5	476	718	5.9	11.8
Kinney	502	795	5.4	10.3	460	806	5.2	10.9	415	764	5.1	11.6	427	823	6.3	12.2	392	887	5.2	12.7	352	420	5.7	13.8	520	399	7.5	13.4	528	739	6.4	12.1	536	631	6.3	11.9	382	819	4.3	11.8	427	213	4.3	11.1	463	235	4.6	10.3	460	627	5.5	11.3
Kleberg	305	614	3.2	11.2	310	400	3.4	11.0	292	533	3.5	11.1	299	591	3.8	11.5	337	584	4.5	11.6	368	327	5.2	11.4	432	353	6.0	11.3	418	361	5.4	11.3	432	339	5.4	11.1	344	788	4.0	11.3	342	746	3.7	11.4	318	604	3.3	11.4	350	520	4.3	11.1
Knox	471	762	4.9	10.7	459	616	5.2	10.7	461	553	5.5	11.1	443	593	5.8	11.0	469	746	6.5	11.5	451	773	6.3	11.6	525	564	7.4	11.6	513	723	6.8	11.0	526	795	6.6	11.2	405	787	4.7	11.2	427	801	4.5	11.1	445	749	4.7	10.6	467	705	5.7	11.8
La Salle	428	502	4.1	11.1	419	507	4.4	10.9	378	767	4.5	11.8	386	636	4.9	12.2	383	764	5.2	12.3	420	276	5.8	13.2	472	240	6.9	12.7	466	490	6.3	12.2	444	658	5.9	11.9	376	842	4.4	11.2	392	372	4.1	10.9	400	313	4.1	10.8	415	531	5.0	11.6
Lamar	399	662	4.1	10.5	373	445	4.0	10.8	361	492	4.3	11.7	356	453	4.5	11.7	364	552	4.8	12.4	364	654	5.0	12.1	417	600	5.8	12.9	431	532	5.6	12.1	419	721	5.1	11.7	369	684	4.2	11.4	373	820	3.8	11.0	359	738	3.6	10.6	382	613	4.6	10.9
Lamb	487	798	5.1	10.2	490	775	5.6	10.3	498	611	6.0	10.9	492	708	6.5	11.0	515	788	7.1	11.2	489	712	6.8	11.4	539	708	7.5	11.1	508	853	6.8	11.2	562	902	7.1	11.2	449	833	5.1	10.9	472	732	5.0	10.7	483	608	5.1	10.5	499	752	6.1	10.9
Lampasas	416	779	4.3	10.9	382	497	4.3	10.8	365	538	4.4	10.9	351	587	4.5	11.0	381	764	5.2	11.2	392	699	5.5	11.4	469	402	6.6	11.1	455	579	6.0	10.4	454	607	5.7	10.7	334	755	3.9	11.2	372	815	4.0	11.1	390	710	4.1	10.2	397	644	4.9	11.2
Lavaca	358	724	3.7	11.0	341	499	3.8	10.9	321	558	3.8	11.0	316	546	4.0	11.3	342	697	4.6	11.5	370	522	5.2	11.6	424	391	6.0	11.3	418	483	5.5	11.1	420	443	5.3	11.2	327	739	3.8	11.2	359	764	3.9	11.2	348	656	3.6	10.8	362	585	4.4	11.0
Lee	377	777	3.9	11.0	349	463	3.9	10.8	321	535	3.8	10.9	310	504	3.9	11.1	338	724	4.5	11.2	370	625	5.2	11.4	422	368	5.9	11.0	421	530	5.5	10.9	416	462	5.2	11.1	307	726	3.5	11.1	364	822	4.0	11.1	363	712	3.8	10.7	363	604	4.4	11.6
Leon	364	705	3.8	10.9	351	491	3.8	11.0	333	534	3.9	11.5	325	492	4.1	11.7	342	648	4.6	12.3	352	572	4.9	12.0	407	494	5.7	12.5	410	458	5.4	11.9	407	590	5.0	11.7	336	696	3.9	11.4	365	789	3.8	11.2	339	695	3.5	10.8	361	597	4.4	11.1
Liberty	320	655	3.4	10.8	304	622	3.3	10.9	310	509	3.6	10.5	313	470	3.9	11.4	323	647	4.3	11.6	340	445	4.7	11.5	369	561	5.2	11.5	360	452	4.8	11.1	383	364	4.8	11.2	339	735	4.0	11.2	346	770	3.9	11.1	300	679	3.2	11.0	334	576	4.1	11.4
Limestone	384	718	4.0	10.8	364	485	4.0	10.9	346	533	4.1	11.4	339	504	4.3	11.5	356	672	4.8	12.0	367	609	5.1	11.9	424	467	6.0	12.1	427	505	5.6	11.5	422	589	5.2	11.5	340	713	3.9	11.3	372	800	3.9	11.1	360	706	3.7	10.6	376	608	4.5	10.9
Lipscomb	480	726	4.8	10.1	458	657	5.0	10.3	449	569	5.4	10.9	464	583	6.0	11.0	464	645	6.3	11.4	458	723	6.4	11.5	496	694	7.0	11.5	501	815	6.6	11.1	520	801	6.4	11.0	426	751	4.8	10.9	431	792	4.4	10.6	458	710	4.6	10.2	468	705	5.6	11.3
Live Oak	335	608	3.5	11.2	336	424	3.7	11.0	311	563	3.7	11.2	317	606	4.0	11.5	347	641	4.7	11.7	376	354	5.3	11.7	442	326	6.2	11.5	430	397	5.6	11.3	437	414	5.5	11.2	345	806	4.0	11.3	355	707	3.8	11.4	340	582	3.5	11.2	365	536	4.5	10.9
Llano	420	791	4.4	10.9	383	526	4.3	10.8	369	545	4.4	10.9	358	642	4.6	11.1	390	792	5.3	11.3	394	708	5.6	11.5	481	397	6.8	11.2	461	562	6.1	10.0	463	631	5.8	10.4	336	744	3.9	11.3	367	804	3.9	11.2	391	694	4.1	9.7	402	653	4.9	11.9
Loving	559	969	5.8	11.6	538	907	6.2	11.7	600	923	7.1	12.0	545	973	7.3	12.0	614	993	8.4	12.1	560	941	7.6	12.1	608	526	8.3	12.1	565	###	7.6	12.0	625	984	8.0	12.0	536	782	6.2	11.4	486	969	5.2	11.7	555	867	5.7	11.6	566	904	7.0	11.1
Lubbock	484	814	5.1	10.2	485	703	5.6	10.4	503	621	6.1	11.4	493	701	6.5	11.4	515	805	7.0	11.7	493	765	6.8	11.7	550	679	7.6	11.7	510	825	6.8	11.5	553	880	6.9	11.6	466	818	5.4	11.0	477	740	5.1	10.7	486	577	5.2	10.3	502	744	6.2	11.4
Lynn	479	834	5.1	10.0	485	634	5.6	10.3	514	634	6.2	11.9	503	699	6.7	11.8	522	826	7.1	12.2	504	811	6.9	12.0	563	675	7.8	12.2	510	806	6.8	12.0	547	870	6.8	12.0	492	808	5.7	11.0	493	729	5.2	10.6	494	502	5.3	10.1	510	736	6.3	11.5
Madison	356	702	3.7	10.9	339	517	3.7	11.0	327	531	3.9	11.3	320	489	4.0	11.6	338	654	4.5	12.1	351	546	4.9	11.9	402	488	5.6	12.2	402	454	5.3	11.7	404	531	5.0	11.5	335	702	3.9	11.4	359	775	3.8	11.2	332	680	3.4	10.8	356	589	4.3	12.3
Marion	354	700	3.7	10.9	366	426	3.9	11.4	338	546	3.9	12.5	319	487	4.0	12.5	334	590	4.4	13.5	330	600	4.4	12.8	394	569	5.4	14.1	409	394	5.3	13.3	397	767	4.8	12.6	334	644	3.8	11.8	375	799	3.8	11.4	331	707	3.3	11.0	357	602	4.2	11.6
Martin	466	844	5.1	9.6	488	430	5.7	10.1	530	599	6.4	12.6	526	639	6.9	12.3	532	817	7.2	13.0	524	845	7.0	12.5	579	759	8.0	13.0	507	764	6.7	12.8	540	857	6.7	12.7	533	787	6.3	11.0	528	619	5.6	10.2	508	171	5.6	9.7	523	678	6.4	10.6
Mason	439	805	4.6	11.0	388	588	4.4	10.9	391	519	4.7	10.8	384	764	4.9	11.2	423	841	5.8	11.3	404	785	5.7	11.4	521	426	7.3	11.3	480	527	6.4	8.7	492	752	6.2	9.4	350	722	4.1	11.4	352	829	3.8	11.4	395	710	4.2	8.5	419	689	5.2	11.2
Matagorda	332	667	3.5	10.9	320	557	3.5	10.9	316	545	3.7	10.8	315	533	4.0	11.4	335	645	4.5	11.7	358	434	5.0	11.6	403	484	5.7	11.5	392	450	5.2	11.2	408	389	5.1	11.2	340	740	4.0	11.2	349	726	3.8	11.2	320	628	3.4	11.0	349	566	4.3	11.8
Maverick	484	707	5.0	10.6	453	717	5.0	11.0	415	778	5.0	11.7	421	770	5.9	12.2	400	857	5.4	12.6	386	403	5.8	13.6	511	357	7.4	13.1	511	673	6.5	12.1	511	667	6.2	12.0	387	827	4.4	11.6	419	292	4.3	11.0	448	284	4.5	10.5	452	611	5.5	10.5

	Jan				Feb				Mar				Apr				May				Jun				Jul				Aug				Sep				Oct				Nov				Dec				Annual			
County	α	β	γ	τ	α	β	γ	τ	α	β	γ	τ	α	β	γ	τ	α	β	γ	τ	α	β	γ	τ	α	β	γ	τ	α	β	γ	τ	α	β	γ	τ	α	β	γ	τ	α	β	γ	τ	α	β	γ	τ	α	β	γ	τ
McCulloch	445	807	4.7	11.0	393	598	4.5	10.9	401	503	4.8	10.8	392	769	5.0	11.1	434	842	6.0	11.2	410	815	5.8	11.3	530	444	7.4	11.3	486	529	6.5	8.5	500	784	6.3	9.2	356	719	4.1	11.4	353	847	3.8	11.4	399	733	4.2	8.4	425	699	5.3	11.2
McLennan	398	743	4.1	10.8	371	485	4.1	10.8	351	530	4.2	11.1	344	522	4.4	11.3	364	709	4.9	11.6	379	648	5.3	11.7	439	435	6.2	11.7	439	541	5.8	11.1	433	579	5.4	11.2	337	728	3.9	11.2	374	803	4.0	11.1	374	702	3.9	10.5	384	619	4.7	11.5
McMullen	379	577	3.8	11.1	374	468	4.0	10.9	344	656	4.1	11.4	349	616	4.4	11.8	364	695	4.9	12.0	396	339	5.5	12.3	456	305	6.5	12.0	446	453	5.9	11.7	440	531	5.7	11.5	358	810	4.2	11.2	371	554	3.9	11.1	367	458	3.8	11.0	388	538	4.7	11.3
Medina	425	709	4.4	10.9	400	571	4.4	10.9	378	649	4.5	11.3	376	675	4.9	11.6	389	783	5.3	11.9	397	521	5.7	12.3	485	367	6.9	11.9	470	561	6.2	11.1	471	617	5.9	11.1	360	779	4.2	11.3	382	591	4.0	11.1	400	509	4.1	10.3	413	611	5.0	10.2
Menard	442	823	4.6	11.0	373	603	4.3	11.0	389	464	4.7	10.6	385	837	4.9	11.0	435	865	6.0	11.1	402	866	5.7	11.1	539	438	7.6	11.1	482	470	6.4	7.3	498	818	6.3	8.2	346	685	4.0	11.5	324	892	3.5	11.5	385	756	4.1	7.2	417	710	5.2	11.6
Midland	479	842	5.2	9.9	492	370	5.8	10.3	531	578	6.4	12.4	520	612	6.9	12.2	533	805	7.2	12.8	520	850	7.0	12.4	580	793	8.0	12.8	514	752	6.8	12.5	550	852	6.8	12.5	519	782	6.1	11.1	512	586	5.4	10.5	508	72	5.5	9.9	523	658	6.4	11.0
Milam	383	769	4.0	10.9	353	470	3.9	10.8	328	533	3.9	10.9	317	506	4.0	11.1	344	717	4.6	11.3	370	627	5.2	11.4	425	384	6.0	11.2	424	526	5.6	11.0	418	488	5.3	11.1	314	723	3.6	11.2	365	815	3.9	11.1	364	710	3.8	10.6	367	606	4.5	10.9
Mills	435	772	4.5	10.9	404	552	4.6	10.8	397	533	4.7	10.9	382	634	4.9	11.1	414	781	5.7	11.3	408	730	5.8	11.5	497	446	7.0	11.3	477	592	6.3	10.2	482	698	6.1	10.5	356	762	4.1	11.3	381	800	4.1	11.2	403	710	4.2	9.9	420	667	5.2	11.5
Mitchell	464	814	5.0	10.0	476	608	5.6	10.3	507	608	6.1	12.2	498	680	6.5	11.9	510	827	6.9	12.6	500	803	6.8	12.2	566	584	7.8	12.6	508	732	6.8	12.1	535	827	6.6	12.2	491	796	5.8	11.0	496	747	5.2	10.5	487	586	5.3	9.8	505	718	6.2	10.8
Montague	458	619	4.6	10.2	393	459	4.3	10.3	404	430	4.9	10.8	404	434	5.2	10.8	410	526	5.5	11.3	407	737	5.7	11.2	460	625	6.5	11.4	466	695	6.2	10.8	452	729	5.5	10.7	411	757	4.8	10.9	376	834	3.9	10.7	397	774	4.0	10.2	420	635	5.1	11.1
Montgomery	331	658	3.5	10.8	315	581	3.4	10.9	316	514	3.7	10.6	313	494	3.9	11.4	327	642	4.4	11.6	344	466	4.8	11.5	382	550	5.4	11.5	373	472	4.9	11.1	391	409	4.9	11.1	336	745	3.9	11.2	348	760	3.8	11.1	311	671	3.3	10.9	341	580	4.2	10.6
Moore	481	763	5.0	10.1	485	814	5.5	10.1	481	565	5.8	10.4	483	684	6.4	10.6	503	745	7.0	10.8	477	645	6.7	11.0	522	728	7.3	10.5	501	860	6.7	10.9	560	906	7.1	10.9	426	847	4.8	10.8	463	718	5.0	10.7	471	636	4.9	10.6	488	743	6.0	12.2
Morris	360	692	3.7	10.8	369	424	4.0	11.3	342	541	3.9	12.5	323	491	4.0	12.4	337	583	4.5	13.4	333	607	4.5	12.7	398	578	5.5	14.0	413	415	5.3	13.2	401	777	4.8	12.5	337	653	3.8	11.7	375	798	3.7	11.3	335	711	3.3	11.0	360	606	4.3	11.0
Motley	479	779	5.0	10.3	473	699	5.4	10.4	480	580	5.8	11.0	472	656	6.2	11.1	492	759	6.7	11.4	472	738	6.6	11.5	532	651	7.4	11.4	508	801	6.8	11.2	543	850	6.8	11.2	435	809	5.0	11.0	453	763	4.8	10.8	468	662	4.9	10.4	485	729	5.9	12.2
Nacogdoches	344	711	3.6	10.9	353	464	3.8	11.4	329	548	3.8	12.4	315	468	3.9	12.4	330	610	4.4	13.4	331	581	4.4	12.7	386	545	5.3	13.9	399	371	5.2	13.2	392	702	4.7	12.5	333	631	3.8	11.7	371	804	3.8	11.4	322	705	3.2	11.1	350	595	4.2	11.6
Navarro	386	704	4.0	10.8	370	473	4.0	11.0	351	529	4.1	11.6	343	500	4.3	11.7	358	646	4.8	12.3	364	622	5.0	12.1	423	510	5.9	12.6	429	496	5.6	11.9	422	652	5.2	11.7	347	700	4.0	11.4	375	793	3.9	11.1	359	699	3.6	10.6	378	610	4.5	12.2
Newton	322	836	3.4	10.9	292	774	3.2	11.4	294	564	3.6	12.3	341	220	4.1	12.4	337	790	4.3	13.3	354	538	4.6	12.6	340	288	4.7	13.8	363	191	4.9	13.1	367	311	4.6	12.5	371	452	4.3	11.7	380	904	4.1	11.4	300	752	3.2	11.1	338	552	4.1	11.2
Nolan	469	798	5.0	10.7	468	629	5.5	10.7	477	572	5.7	11.4	454	630	5.9	11.2	485	814	6.7	11.8	464	797	6.5	11.7	547	524	7.6	11.8	520	695	6.9	11.1	538	801	6.8	11.4	416	795	4.9	11.2	444	797	4.7	11.2	456	735	4.9	10.5	479	716	5.9	11.3
Nueces	291	594	3.1	11.3	301	361	3.3	11.0	279	484	3.4	11.0	289	610	3.7	11.4	331	585	4.4	11.5	359	321	5.1	11.2	429	325	6.0	11.1	416	328	5.4	11.1	435	312	5.5	11.1	338	826	3.9	11.3	343	820	3.7	11.6	315	664	3.3	11.6	344	519	4.2	10.8
Ochiltree	480	748	4.9	10.1	468	710	5.2	10.3	461	575	5.6	10.8	471	623	6.2	10.9	479	693	6.5	11.2	466	705	6.5	11.3	509	695	7.1	11.2	501	828	6.6	11.0	534	837	6.6	11.0	427	784	4.8	10.9	443	767	4.6	10.6	464	677	4.7	10.4	476	720	5.8	10.6
Oldham	483	771	5.0	10.1	489	825	5.5	10.2	485	575	5.9	10.4	486	693	6.5	10.7	508	759	7.0	10.8	481	649	6.8	11.0	526	730	7.3	10.5	502	865	6.7	10.9	563	914	7.1	10.9	430	851	4.8	10.8	467	716	5.0	10.7	475	628	5.0	10.6	491	748	6.1	12.2
Orange	315	850	3.4	10.9	281	822	3.1	11.4	287	564	3.6	12.2	342	189	4.1	12.3	335	817	4.2	13.2	354	522	4.6	12.6	332	257	4.6	13.7	354	165	4.8	13.0	361	249	4.5	12.4	375	434	4.4	11.7	381	913	4.1	11.4	294	754	3.2	11.1	334	545	4.1	11.0
Palo Pinto	448	740	4.6	10.7	423	554	4.8	10.7	420	517	5.0	11.0	406	567	5.3	11.0	430	705	5.9	11.5	420	745	5.9	11.5	496	539	7.0	11.5	488	659	6.5	10.8	493	728	6.1	10.9	380	769	4.4	11.2	398	815	4.2	11.1	415	754	4.3	10.4	435	674	5.3	12.4
Panola	346	707	3.6	10.9	360	433	3.9	11.4	332	549	3.8	12.6	313	481	3.9	12.5	329	594	4.4	13.5	327	593	4.4	12.8	389	564	5.3	14.2	403	373	5.2	13.4	392	756	4.7	12.7	330	632	3.7	11.8	373	802	3.7	11.4	324	706	3.2	11.1	351	599	4.2	11.0
Parker	436	715	4.5	10.6	403	520	4.5	10.6	399	499	4.8	11.0	391	530	5.0	11.1	409	661	5.6	11.5	405	716	5.7	11.5	473	547	6.6	11.6	470	633	6.2	10.9	470	696	5.8	11.0	378	749	4.4	11.2	388	815	4.1	11.0	400	741	4.1	10.4	419	652	5.1	10.8
Parmer	488	792	5.1	10.2	492	804	5.6	10.3	494	607	6.0	10.7	491	707	6.5	10.9	515	781	7.1	11.0	488	692	6.8	11.2	534	717	7.4	10.9	506	863	6.8	11.1	564	909	7.1	11.1	443	839	5.0	10.9	470	731	5.0	10.7	483	622	5.1	10.5	498	755	6.1	11.8
Pecos	550	950	5.8	11.3	528	887	6.1	11.4	575	900	6.8	11.8	518	958	6.8	12.0	567	994	7.7	12.1	531	947	7.2	12.3	611	570	8.4	11.8	549	972	7.3	12.0	609	980	7.6	12.0	489	858	5.6	11.6	466	931	5.0	11.6	529	826	5.4	11.4	544	898	6.7	11.6
Polk	336	704	3.5	10.9	322	583	3.5	11.1	317	532	3.7	11.4	320	438	4.0	11.8	331	660	4.4	12.4	344	511	4.7	12.0	378	497	5.3	12.5	381	396	5.0	12.0	389	473	4.8	11.7	343	661	4.0	11.4	360	794	3.9	11.2	313	692	3.3	11.0	345	578	4.2	10.5
Potter	477	752	5.0	10.0	486	843	5.5	10.1	479	537	5.8	10.1	481	689	6.4	10.4	501	740	7.0	10.5	474	603	6.7	10.8	520	741	7.3	10.2	497	865	6.6	10.7	565	923	7.2	10.7	416	869	4.6	10.7	464	696	5.0	10.7	466	627	4.9	10.6	486	740	6.0	12.2
Presidio	602	911	6.4	11.2	565	940	6.6	11.0	641	957	7.7	12.3	531	###	7.1	12.7	612	1011	8.3	12.7	573	980	7.8	14.0	582	841	7.9	13.4	556	997	7.5	13.0	621	992	7.9	12.7	563	913	6.5	11.1	501	958	5.4	10.7	565	950	5.8	11.0	576	954	7.1	12.0
Rains	373	690	3.9	10.8	371	433	4.0	11.2	349	526	4.1	12.1	333	488	4.2	12.1	347	587	4.6	13.0	345	625	4.7	12.5	408	577	5.7	13.5	420	457	5.4	12.7	409	749	4.9	12.2	345	670	3.9	11.6	375	802	3.8	11.2	345	713	3.4	10.8	369	610	4.4	10.4
Randall	475	747	5.0	10.0	486	854	5.5	10.0	478	526	5.8	10.0	480	690	6.4	10.4	501	738	7.0	10.4	472	585	6.7	10.7	518	747	7.3	10.1	496	867	6.6	10.7	567	929	7.2	10.7	411	877	4.6	10.7	465	688	5.0	10.7	464	623	4.9	10.7	484	739	6.0	11.5
Reagan	485	857	5.2	10.3	484	615	5.6	10.6	513	682	6.2	12.0	496	755	6.6	12.0	514	874	7.0	12.5	496	825	6.8	12.4	573	629	7.9	12.5	516	783	6.8	12.0	551	857	6.8	12.1	482	807	5.6	11.2	481	707	5.1	10.8	493	456	5.3	10.1	509	737	6.2	11.2
Real	461	781	4.8	10.8	422	665	4.8	10.9	409	651	4.9	11.3	405	771	5.4	11.7	417	848	5.7	12.0	398	616	5.8	12.4	519	414	7.3	12.1	497	621	6.4	10.5	507	699	6.3	10.7	374	773	4.3	11.5	390	583	4.1	11.2	425	515	4.4	9.6	439	661	5.4	11.8
Red River	384	680	3.9	10.6	371	447	4.0	11.0	354	512	4.1	12.0	345	466	4.4	11.9	354	570	4.7	12.8	354	637	4.8	12.3	409	590	5.7	13.3	424	488	5.5	12.5	413	730	5.0	12.0	357	669	4.1	11.5	375	814	3.8	11.1	351	727	3.5	10.7	375	611	4.5	11.9
Reeves	566	987	5.9	11.8	543	955	6.3	11.8	610	961	7.2	12.0	550	###	7.4	12.0	624	1014	8.6	12.1	567	959	7.7	12.1	614	497	8.4	12.1	571	###	7.7	12.0	633	###	8.1	12.0	543	778	6.2	11.5	486	###	5.2	11.8	562	942	5.7	11.8	573	931	7.0	11.3
Refugio	312	624	3.3	11.2	315	413	3.5	11.0	295	520	3.5	11.1	300	595	3.8	11.4	337	612	4.5	11.6	365	361	5.1	11.4	430	350	6.0	11.3	418	368	5.4	11.2	433	355	5.4	11.1	339	795	3.9	11.3	347	774	3.7	11.5	324	636	3.4	11.3	351	533	4.3	10.8
Roberts	479	749	4.9	10.1	470	729	5.3	10.2	465	565	5.6	10.7	471	635	6.2	10.8	483	705	6.6	11.1	466	690	6.5	11.2	513	697	7.2	11.0	501	830	6.6	11.0	539	854	6.7	10.9	426	802	4.8	10.9	447	754	4.7	10.7	464	666	4.8	10.4	478	723	5.8	11.3
Robertson	374	727	3.9	10.9	350	496	3.9	10.9	333	532	4.0	11.1	325	502	4.1	11.4	347	680	4.7	11.7	364	584	5.1	11.7	419	442	5.9	11.7	417	490	5.5	11.3	415	525	5.2	11.3	331	714	3.8	11.3	364	786	3.9	11.1	351	689	3.6	10.7	366	597	4.5	11.5
Rockwall	399	685	4.1	10.6	375	465	4.1	10.9	363	499	4.3	11.6	356	477	4.5	11.6	368	594	4.9	12.3	368	655	5.1	12.0	426	570	5.9	12.6	435	533	5.7	11.9	427	697	5.2	11.6	363	697	4.2	11.3	376	814	3.8	11.1	363	728	3.7	10.6	385	618	4.6	11.0
Runnels	463	798	4.9	11.0	446	623	5.2	10.9	451	546	5.4	11.1	427	662	5.6	11.1	466	821	6.4	11.5	442	801	6.2	11.5	540	488	7.6	11.5	514	640	6.8	10.2	528	793	6.7	10.6	384	775	4.5	11.3	408	817	4.4	11.4	433	757	4.6	10.1	459	710	5.7	12.6
Rusk	344	700	3.6	11.0	369	386	4.0	11.5	335	552	3.8	12.9	305	510	3.8	12.7	324	574	4.3	13.8	316	603	4.2	13.0	390	598	5.3	14.6	405	370	5.2	13.7	392	837	4.7	12.9	322	641	3.6	11.9	375	794	3.7	11.5	323	701	3.2	11.2	350	605	4.1	12.1
Sabine	335	768	3.5	10.9	320	632	3.5	11.3	312	553	3.7	12.1	331	344	4.0	12.2	336	701	4.4	13.1	348	551	4.6	12.5	366	412	5.1	13.5	382	297	5.0	12.8	382	473	4.7	12.3	355	550	4.1	11.7	373	850	3.9	11.3	313	727	3.3	11.0	346	571	4.2	12.1
San Augustine	339	740	3.6	10.9	332	567	3.6	11.3	319	548	3.8	12.1	325	398	4.0	12.2	334	664	4.4	13.1	343	558	4.6	12.5	375	468	5.2	13.5	389	337	5.1	12.8	387	551	4.7	12.3	346	591	4.0	11.7	371	828	3.9	11.3	317	716	3.3	11.0	348	581	4.2	11.4
San Jacinto	333	677	3.5	10.8	318	582	3.4	11.0	317	521	3.7	10.9	316	470	4.0	11.6	329	649	4.4	12.0	344	485	4.8	11.7	381	528	5.4	12.0	377	438	5.0	11.5	390	439	4.9	11.4	339	709	3.9	11.3	353	773	3.8	11.2	312	679	3.3	11.0	343	579	4.2	11.2
San Patricio	289	589	3.1	11.3	300	351	3.3	11.0	277	475	3.3	11.0	287	614	3.7	11.4	330	586	4.4	11.4	358	321	5.1	11.1	429	318	6.0	11.1	416	323	5.4	11.1	436	309	5.5	11.0	336	837	3.9	11.3	343	836	3.7	11.6	315	677	3.3	11.6	343	520	4.2	10.8
San Saba	435	785	4.5	10.9	396	556	4.5	10.9	391	532	4.7	10.9	379	673	4.9	11.1	413	801	5.6	11.3	405	746	5.7	11.4	502	431	7.1	11.3	475	569	6.3	9.7	482	703	6.1	10.2	352	748	4.1	11.3	370	811	4.0	11.3	400	709	4.2	9.5	417	672	5.1	10.9
Schleicher	464	824	4.9	10.8	422	650	4.8	10.9	432	584	5.2	11.1	422	802	5.5	11.4	454	870	6.2	11.6	427	788	6.1	11.8	544	471	7.6	11.7	500	613	6.6	9.5	520	801	6.5	10.0	388	752	4.5	11.5	386	773	4.1	11.3	428	655	4.5	8.9	451	715	5.5	11.4
Scurry	469	808	5.0	10.1	477	621	5.6	10.4	501	605	6.1	11.9	491	666	6.4	11.8	506	814	6.9	12.3	493	796	6.7	12.1	560	590	7.8	12.4	511	744	6.8	11.9	538	827	6.7	12.0	476	796	5.6	11.1	484	755	5.1	10.6	482	613	5.2	10.0	500	720	6.2	11.2
Shackelford	466	786	4.9	11.1	470	627	5.5	10.9	464	544	5.5	11.0	432	564	5.6	10.8	473	789	6.6	11.4	448	796	6.4	11.4	534	506	7.5	11.4	529	685	7.1	10.9	540	781	6.8	11.2	376	797	4.4	11.3	425	828	4.5	11.5	439	826	4.6	11.2	467	711	5.8	12.2
Shelby	344	723	3.6	10.9	347	499	3.7	11.4	326	548	3.8	12.3	320	441	4.0	12.3	332	628	4.4	13.3	336	577	4.5	12.7	383	516	5.3	13.8	397	358	5.2	13.1	391	654	4.7	12.5	339	612	3.9	11.7	372	814	3.8	11.4	321	711	3.3	11.0	351	590	4.2	10.7
Sherman	486	771	5.0	10.1	484	787	5.4	10.2	481	591	5.8	10.6	484	675	6.4	10.8	503	745	6.9	11.0	480	685	6.7	11.2	523	717	7.3	10.9	504	856	6.7	11.0	555	887	7.0	11.0	435	824	4.9	10.8	461	740	4.9	10.7	476	648	4.9	10.5	490	744	6.0	12.5
Smith	347	698	3.6	11.0	371	381	4.0	11.5	337	551	3.8	12.8	307	513	3.8	12.7	326	572	4.3	13.8	317	606	4.2	13.0	392	600	5.4	14.5	407	378	5.2	13.7	393	843	4.7	12.9	323	645	3.6	11.9	375	792	3.7	11.5	325	701	3.2	11.1	352	607	4.1	11.1

County	Jan				Feb				Mar				Apr				May				Jun				Jul				Aug				Sep				Oct				Nov				Dec				Annual			
	α	β	γ	τ	α	β	γ	τ	α	β	γ	τ	α	β	γ	τ	α	β	γ	τ	α	β	γ	τ	α	β	γ	τ	α	β	γ	τ	α	β	γ	τ	α	β	γ	τ	α	β	γ	τ	α	β	γ	τ	α	β	γ	τ
Somervell	425	726	4.4	10.7	397	512	4.4	10.7	386	520	4.6	11.1	377	550	4.8	11.2	397	699	5.4	11.6	399	686	5.6	11.6	469	492	6.6	11.7	465	595	6.1	10.9	463	664	5.8	11.0	361	748	4.2	11.2	384	790	4.0	11.1	395	707	4.1	10.3	411	641	5.0	11.3
Starr	348	643	3.6	11.1	337	403	3.7	10.9	321	665	3.8	11.2	336	503	4.2	11.4	365	587	4.9	11.8	397	351	5.5	11.7	447	396	6.3	11.4	423	554	5.5	11.6	419	452	5.4	11.1	353	786	4.1	11.1	334	631	3.6	10.8	325	490	3.4	11.0	367	539	4.5	11.1
Stephens	459	769	4.8	10.9	446	597	5.1	10.8	444	534	5.3	11.0	421	579	5.5	10.9	453	754	6.3	11.4	435	775	6.2	11.4	518	525	7.3	11.5	509	675	6.8	10.8	518	759	6.5	11.0	380	781	4.4	11.3	412	820	4.4	11.3	429	782	4.5	10.7	453	696	5.6	11.5
Sterling	466	825	5.0	10.0	474	602	5.5	10.3	507	625	6.1	12.2	499	712	6.6	12.0	510	843	6.9	12.6	499	806	6.8	12.3	568	590	7.9	12.7	507	734	6.7	12.1	535	833	6.6	12.2	494	796	5.8	11.1	494	729	5.2	10.5	488	530	5.3	9.7	505	719	6.2	11.2
Stonewall	471	791	5.0	10.7	469	634	5.4	10.7	475	567	5.7	11.3	452	612	5.9	11.1	482	786	6.6	11.7	461	792	6.5	11.6	539	555	7.5	11.7	520	720	6.9	11.2	538	804	6.8	11.4	411	794	4.8	11.2	440	804	4.7	11.2	454	749	4.8	10.7	477	717	5.9	11.1
Sutton	473	821	5.0	10.8	431	684	4.9	10.9	431	628	5.2	11.2	423	812	5.6	11.6	445	878	6.1	11.8	416	728	6.0	12.1	541	458	7.6	11.9	505	646	6.6	10.0	524	776	6.5	10.4	387	771	4.5	11.5	393	687	4.1	11.3	436	594	4.5	9.2	453	707	5.6	10.5
Swisher	478	758	5.0	10.1	486	828	5.5	10.1	481	546	5.8	10.3	482	690	6.4	10.6	503	747	7.0	10.6	475	621	6.7	10.9	523	733	7.3	10.4	499	860	6.7	10.8	564	917	7.1	10.8	421	863	4.7	10.7	465	702	5.0	10.7	468	625	5.0	10.6	487	741	6.0	11.1
Tarrant	422	699	4.3	10.5	387	496	4.3	10.7	381	489	4.5	11.2	377	495	4.8	11.2	391	629	5.3	11.7	391	688	5.5	11.6	451	549	6.3	11.9	454	595	6.0	11.1	450	672	5.5	11.1	373	726	4.3	11.2	381	816	4.0	11.0	384	734	3.9	10.4	404	632	4.9	11.2
Taylor	468	791	4.9	11.2	475	635	5.6	11.0	470	545	5.6	11.1	434	563	5.6	10.8	478	802	6.7	11.4	451	801	6.4	11.4	540	498	7.6	11.4	534	682	7.1	10.9	545	786	6.9	11.3	374	802	4.4	11.3	428	828	4.6	11.6	442	835	4.7	11.3	470	714	5.8	11.8
Terrell	551	967	5.8	11.3	526	964	6.1	11.3	564	945	6.7	11.6	506	###	6.6	12.0	545	1029	7.4	12.1	513	965	7.0	12.2	621	536	8.5	11.5	546	996	7.2	12.0	609	###	7.5	12.0	458	908	5.2	11.9	449	961	4.8	11.7	518	913	5.3	11.6	535	933	6.5	11.3
Terry	490	847	5.2	10.2	491	643	5.7	10.5	520	657	6.3	11.7	504	716	6.7	11.7	529	838	7.2	12.1	507	822	6.9	12.0	564	685	7.8	12.1	515	824	6.9	11.9	556	882	6.9	11.9	490	807	5.7	11.1	488	732	5.2	10.7	499	489	5.3	10.3	514	745	6.3	11.1
Throckmorton	466	769	4.9	10.9	456	610	5.3	10.8	455	540	5.4	11.1	432	575	5.6	10.9	464	755	6.4	11.5	444	784	6.3	11.5	524	537	7.3	11.5	515	698	6.9	10.9	526	777	6.6	11.1	389	786	4.5	11.2	420	820	4.4	11.3	437	788	4.6	10.8	461	703	5.7	12.1
Titus	365	689	3.8	10.8	370	427	4.0	11.3	344	536	4.0	12.4	327	488	4.1	12.3	341	581	4.5	13.2	337	612	4.6	12.6	401	580	5.5	13.8	415	429	5.4	13.0	404	771	4.9	12.4	340	657	3.9	11.7	375	800	3.8	11.3	338	713	3.4	10.9	363	607	4.3	10.9
Tom Green	464	814	4.9	10.7	433	628	5.0	10.8	448	569	5.4	11.2	434	755	5.7	11.4	466	850	6.4	11.7	443	804	6.2	11.7	547	496	7.6	11.7	503	629	6.7	10.0	523	809	6.6	10.4	405	760	4.7	11.3	406	791	4.3	11.2	437	670	4.6	9.2	460	715	5.7	10.8
Travis	388	846	4.1	11.0	350	416	3.9	10.7	310	532	3.7	10.7	293	488	3.6	10.7	326	768	4.4	10.7	371	709	5.2	11.1	418	308	5.9	10.4	423	576	5.6	10.7	409	435	5.2	11.0	279	725	3.2	11.0	363	890	4.0	11.0	376	765	3.9	10.6	359	622	4.4	11.8
Trinity	344	701	3.6	10.9	337	524	3.6	11.2	324	536	3.8	11.6	319	464	4.0	11.9	333	637	4.4	12.6	342	541	4.7	12.2	388	517	5.4	12.9	393	407	5.1	12.2	394	564	4.8	11.9	338	665	3.9	11.5	363	791	3.8	11.3	321	693	3.3	11.0	350	587	4.2	11.8
Tyler	331	747	3.5	10.9	312	646	3.4	11.2	309	543	3.7	11.7	327	365	4.0	12.0	333	700	4.4	12.7	348	520	4.7	12.2	365	431	5.1	13.0	375	328	5.0	12.4	381	420	4.7	12.0	353	590	4.1	11.5	367	832	3.9	11.3	309	714	3.3	11.0	343	570	4.1	12.5
Upshur	349	697	3.7	10.9	371	389	4.0	11.5	338	550	3.9	12.8	309	508	3.9	12.6	327	574	4.4	13.8	320	606	4.3	13.0	393	596	5.4	14.5	408	382	5.2	13.6	394	831	4.7	12.9	325	646	3.7	11.9	375	794	3.7	11.4	327	703	3.2	11.1	353	606	4.2	11.6
Upton	503	867	5.4	10.5	498	558	5.8	10.8	534	679	6.4	12.0	506	729	6.7	12.1	532	866	7.2	12.4	509	856	6.9	12.4	583	693	8.1	12.4	525	807	7.0	12.1	567	877	7.1	12.1	490	806	5.7	11.3	482	691	5.1	11.0	506	350	5.3	10.5	521	732	6.4	11.5
Uvalde	461	739	4.8	10.7	429	666	4.8	10.9	404	702	4.9	11.4	405	747	5.5	11.8	404	834	5.5	12.2	394	510	5.8	12.8	508	384	7.2	12.5	496	632	6.4	11.3	501	663	6.2	11.3	377	795	4.3	11.5	401	473	4.2	11.1	429	424	4.4	10.2	439	631	5.3	11.8
Val Verde	514	841	5.5	10.5	476	837	5.4	11.0	451	789	5.5	11.6	448	863	6.4	12.1	429	920	5.8	12.6	388	554	6.0	13.4	544	445	7.7	13.0	534	801	6.6	12.0	555	716	6.6	11.9	402	836	4.6	11.8	436	381	4.5	11.2	478	379	4.8	10.5	479	697	5.8	12.1
Van Zandt	367	692	3.8	10.8	370	428	4.0	11.2	345	536	4.0	12.2	328	495	4.1	12.2	342	595	4.6	13.1	341	614	4.6	12.6	405	567	5.6	13.6	417	438	5.4	12.9	406	753	4.9	12.3	340	668	3.9	11.6	375	794	3.8	11.3	341	703	3.4	10.9	365	607	4.3	11.3
Victoria	339	672	3.5	11.1	331	477	3.6	11.0	313	553	3.7	11.0	313	570	4.0	11.4	342	654	4.6	11.6	369	432	5.2	11.6	428	383	6.0	11.4	418	427	5.5	11.2	427	408	5.4	11.2	337	757	3.9	11.3	353	740	3.8	11.3	336	623	3.5	11.1	359	558	4.4	11.4
Walker	344	687	3.6	10.9	329	548	3.6	11.0	322	526	3.8	11.1	318	482	4.0	11.6	333	649	4.5	12.0	347	513	4.8	11.8	392	511	5.5	12.1	389	447	5.1	11.6	397	486	4.9	11.5	337	707	3.9	11.3	356	771	3.8	11.2	321	677	3.4	10.9	349	584	4.2	11.1
Waller	340	671	3.5	10.8	321	559	3.5	10.9	318	521	3.7	10.6	314	505	3.9	11.3	331	651	4.5	11.5	350	481	4.9	11.5	393	516	5.5	11.4	385	479	5.1	11.0	399	418	5.0	11.1	334	745	3.9	11.2	349	756	3.8	11.1	320	665	3.4	10.9	346	581	4.2	11.8
Ward	554	951	5.8	11.5	534	841	6.2	11.6	593	879	7.0	12.0	539	929	7.2	12.0	602	971	8.3	12.1	553	929	7.5	12.2	607	557	8.3	12.1	561	977	7.5	12.0	619	967	7.9	12.0	529	789	6.1	11.5	484	919	5.2	11.7	549	768	5.6	11.5	561	873	6.9	11.1
Washington	359	714	3.7	10.9	336	516	3.7	10.9	322	532	3.8	10.9	316	507	4.0	11.3	337	680	4.5	11.5	360	541	5.0	11.5	409	446	5.8	11.4	405	490	5.3	11.1	409	457	5.1	11.2	327	729	3.8	11.2	356	775	3.9	11.1	339	676	3.5	10.8	357	588	4.4	12.1
Webb	458	335	4.1	11.2	456	476	4.6	10.9	395	886	4.7	12.2	411	622	5.0	12.6	389	801	5.3	12.7	447	115	6.0	14.1	473	110	7.1	13.4	475	460	6.6	12.9	427	770	5.9	12.5	389	897	4.5	11.1	408	162	4.2	10.6	420	135	4.2	11.0	429	481	5.2	11.2
Wharton	339	675	3.5	10.9	325	548	3.5	10.9	318	538	3.8	10.7	316	527	4.0	11.4	335	656	4.5	11.6	358	463	5.0	11.5	404	481	5.7	11.4	394	468	5.2	11.1	408	407	5.1	11.1	336	745	3.9	11.2	352	741	3.9	11.1	325	645	3.4	10.9	351	575	4.3	10.8
Wheeler	479	732	4.9	10.1	460	669	5.1	10.3	457	555	5.5	10.8	463	599	6.1	10.9	471	673	6.4	11.3	459	719	6.4	11.4	506	680	7.1	11.3	500	810	6.6	11.0	525	826	6.5	11.0	426	780	4.8	10.9	435	778	4.5	10.7	457	693	4.7	10.3	470	710	5.7	10.9
Wichita	474	672	4.8	10.3	425	530	4.7	10.4	434	484	5.2	10.9	429	507	5.6	10.9	441	601	6.0	11.3	431	768	6.0	11.3	490	625	6.9	11.4	489	745	6.5	10.8	487	772	6.0	10.8	417	771	4.8	11.0	397	828	4.1	10.8	424	775	4.3	10.3	445	673	5.4	10.9
Wilbarger	473	711	4.8	10.4	439	573	4.9	10.5	444	516	5.3	11.0	437	548	5.7	11.0	452	656	6.2	11.4	440	764	6.2	11.4	502	613	7.1	11.5	497	744	6.6	10.9	504	779	6.2	11.0	413	774	4.8	11.0	410	815	4.3	10.9	434	757	4.5	10.4	454	687	5.5	11.5
Willacy	299	760	3.2	11.1	292	562	3.2	11.2	310	653	3.6	11.3	297	507	3.8	11.7	340	461	4.6	12.5	383	326	5.2	11.8	425	558	5.7	11.6	406	387	5.2	11.9	414	263	5.1	11.2	368	528	4.2	11.2	312	504	3.5	11.1	284	391	3.0	11.0	344	492	4.2	10.9
Williamson	389	825	4.1	11.0	353	431	4.0	10.7	317	532	3.8	10.8	302	499	3.8	10.8	334	759	4.5	10.9	373	691	5.2	11.2	424	327	6.0	10.6	426	566	5.6	10.7	414	457	5.2	11.0	290	728	3.3	11.1	365	868	4.0	11.0	375	748	3.9	10.6	364	619	4.4	11.2
Wilson	378	706	3.9	11.0	360	481	4.0	10.9	335	585	4.0	11.1	330	586	4.2	11.4	356	714	4.8	11.5	382	506	5.4	11.7	448	353	6.3	11.4	438	494	5.7	11.1	438	489	5.5	11.2	334	763	3.9	11.2	365	715	3.9	11.2	366	607	3.8	10.7	378	583	4.6	11.8
Winkler	542	922	5.7	11.3	527	744	6.1	11.4	579	809	6.9	12.0	532	856	7.1	12.0	588	932	8.0	12.2	545	903	7.4	12.2	599	611	8.2	12.2	552	920	7.4	12.1	607	937	7.7	12.0	521	791	6.0	11.4	485	839	5.2	11.5	540	622	5.6	11.3	552	824	6.8	11.0
Wise	442	674	4.5	10.4	397	493	4.4	10.5	398	471	4.8	11.0	394	484	5.1	11.0	407	601	5.5	11.5	403	717	5.7	11.4	463	580	6.5	11.6	466	648	6.2	10.9	460	704	5.7	10.9	390	745	4.5	11.1	383	821	4.0	10.9	396	751	4.0	10.3	417	641	5.1	12.3
Wood	356	694	3.7	10.9	370	403	4.0	11.4	341	544	3.9	12.6	316	502	4.0	12.5	333	579	4.4	13.5	328	609	4.4	12.8	397	588	5.5	14.2	411	404	5.3	13.4	398	805	4.8	12.7	331	653	3.7	11.8	375	794	3.7	11.4	332	704	3.3	11.0	357	607	4.2	11.4
Yoakum	503	862	5.4	10.4	498	684	5.8	10.6	528	693	6.4	11.7	507	746	6.7	11.7	540	857	7.3	12.0	512	836	7.0	12.0	566	676	7.8	12.0	520	849	7.0	11.8	565	894	7.1	11.8	490	807	5.7	11.1	483	759	5.2	10.9	506	536	5.3	10.5	519	767	6.4	11.0
Young	462	744	4.8	10.7	439	579	5.0	10.7	440	525	5.3	11.0	423	565	5.5	11.0	448	713	6.1	11.4	433	769	6.1	11.4	508	555	7.1	11.5	501	695	6.7	10.8	508	761	6.3	11.0	391	776	4.5	11.2	408	819	4.3	11.1	427	771	4.4	10.6	450	689	5.5	11.9
Zapata	425	427	3.9	11.2	421	466	4.3	10.9	375	821	4.4	11.9	388	593	4.8	12.3	381	736	5.2	12.5	433	184	5.9	13.4	465	201	6.8	12.9	460	476	6.3	12.6	425	672	5.8	12.1	380	853	4.4	11.1	387	291	4.0	10.7	392	234	4.0	11.0	411	496	5.0	11.7
Zavala	458	664	4.7	10.8	433	633	4.7	10.9	401	744	4.8	11.6	404	720	5.4	12.0	399	819	5.4	12.3	402	420	5.8	13.1	499	337	7.2	12.7	491	604	6.4	11.8	487	665	6.1	11.7	381	816	4.4	11.4	404	404	4.2	11.0	426	361	4.3	10.5	436	599	5.3	11

Table 13. Estimated monthly and annual averages of diffuse horizontal radiation by county in Texas. Average W/m^2 are represented by α, peak W/m^2 by β and total energy in kWh/m^2/day by γ. Average daylight hours are estimated by τ.

	Jan				Feb				Mar				Apr				May				Jun				Jul				Aug				Sep				Oct				Nov				Dec				Annual			
County	α	β	γ	τ	α	β	γ	τ	α	β	γ	τ	α	β	γ	τ	α	β	γ	τ	α	β	γ	τ	α	β	γ	τ	α	β	γ	τ	α	β	γ	τ	α	β	γ	τ	α	β	γ	τ	α	β	γ	τ	α	β	γ	τ
Anderson	83	208	0.9	10.9	107	194	1.2	11.3	117	169	1.5	12.2	153	157	2.0	12.2	162	140	2.3	13.1	162	198	2.3	12.6	141	220	2.1	13.6	136	214	1.9	12.9	131	135	1.7	12.3	109	131	1.3	11.7	85	124	1.0	11.3	75	213	0.8	11.0	121	175	1.6	11.6
Andrews	84	95	0.9	10.5	103	188	1.2	10.8	112	154	1.4	12.1	134	132	1.8	12.0	141	88	1.9	12.4	141	91	2.0	12.3	119	191	1.7	12.4	125	138	1.7	12.2	108	87	1.4	12.2	95	130	1.2	11.2	85	159	0.9	10.9	75	186	0.8	10.5	111	137	1.4	12.0
Angelina	92	196	1.0	10.9	118	203	1.3	11.3	127	187	1.6	12.0	162	181	2.1	12.2	170	147	2.4	13.0	170	221	2.4	12.4	152	236	2.2	13.4	145	236	2.0	12.7	137	174	1.8	12.2	117	162	1.4	11.6	91	129	1.0	11.3	83	215	0.9	11.0	130	191	1.7	11.3
Aransas	104	198	1.2	11.2	125	220	1.5	11.0	142	221	1.8	11.1	173	229	2.3	11.5	177	188	2.5	11.6	177	229	2.4	11.4	136	206	2.0	11.3	142	325	1.9	11.2	131	246	1.7	11.1	126	135	1.5	11.3	100	171	1.1	11.5	92	174	1.0	11.3	134	212	1.7	11.0
Archer	83	179	0.9	10.5	107	216	1.2	10.5	123	165	1.5	11.0	151	130	2.0	10.9	153	166	2.2	11.4	153	190	2.3	11.4	132	203	1.9	11.5	132	180	1.8	10.8	120	158	1.5	10.9	104	143	1.2	11.1	91	128	1.0	11.0	78	164	0.8	10.4	119	168	1.5	10.5
Armstrong	83	152	0.9	10.1	95	151	1.1	10.1	110	252	1.3	10.3	132	166	1.8	10.5	132	249	1.9	10.6	132	280	2.0	10.9	126	207	1.8	10.3	128	153	1.7	10.8	99	161	1.3	10.8	109	139	1.2	10.7	78	148	0.8	10.7	73	147	0.7	10.6	109	184	1.4	11.4
Atascosa	96	223	1.1	11.0	118	220	1.4	10.9	134	179	1.7	11.3	161	198	2.1	11.6	172	175	2.4	11.8	172	207	2.3	12.1	134	192	1.9	11.8	138	265	1.9	11.3	130	210	1.7	11.3	119	142	1.4	11.3	95	170	1.1	11.1	86	173	0.9	10.7	129	196	1.6	11.1
Austin	97	222	1.1	10.9	122	216	1.4	10.9	136	187	1.7	10.7	171	183	2.2	11.3	179	198	2.5	11.5	179	249	2.4	11.5	149	230	2.2	11.4	148	236	2.0	11.1	134	225	1.7	11.1	119	154	1.4	11.2	96	174	1.1	11.1	86	198	0.9	10.8	134	206	1.7	11.0
Bailey	83	138	0.9	10.2	99	163	1.1	10.4	112	193	1.4	11.1	134	144	1.8	11.2	136	177	1.9	11.4	136	201	2.0	11.5	124	191	1.8	11.3	127	161	1.7	11.4	104	139	1.3	11.4	102	150	1.2	11.0	83	145	0.9	10.8	75	155	0.8	10.5	110	163	1.4	11.1
Bandera	86	187	0.9	10.9	111	211	1.3	10.9	126	155	1.6	11.2	150	159	2.0	11.5	157	155	2.2	11.7	157	182	2.3	12.1	123	178	1.8	11.8	130	222	1.8	10.5	120	180	1.5	10.8	111	162	1.3	11.4	91	160	1.0	11.2	79	146	0.9	9.9	121	175	1.5	10.9
Bastrop	89	195	1.0	11.0	113	244	1.3	10.7	129	162	1.6	10.8	166	143	2.2	10.9	179	196	2.5	11.0	179	209	2.4	11.2	142	176	2.1	10.7	145	193	1.9	10.8	132	212	1.7	11.0	118	143	1.4	11.1	89	138	1.0	11.0	75	194	0.8	10.6	129	184	1.7	11.0
Baylor	82	174	0.9	10.6	106	217	1.2	10.6	122	171	1.5	11.0	150	126	2.0	11.0	150	167	2.1	11.5	150	185	2.2	11.5	129	207	1.9	11.5	129	187	1.8	10.9	117	163	1.5	11.1	105	146	1.3	11.1	89	133	1.0	11.1	77	175	0.8	10.6	118	171	1.5	11.3
Bee	103	200	1.2	11.2	123	226	1.5	11.0	140	217	1.8	11.1	172	227	2.3	11.4	176	186	2.5	11.5	176	226	2.4	11.4	132	201	1.9	11.3	140	328	1.9	11.2	129	247	1.7	11.1	125	127	1.5	11.3	98	167	1.1	11.5	90	171	1.0	11.4	133	210	1.7	11.0
Bell	87	194	0.9	10.9	112	237	1.3	10.8	127	163	1.6	10.9	162	145	2.1	11.0	173	183	2.4	11.2	173	203	2.4	11.3	138	184	2.0	11.0	142	195	1.9	10.8	130	198	1.7	11.0	115	142	1.4	11.1	89	140	1.0	11.1	76	189	0.8	10.5	126	181	1.6	11.2
Bexar	91	204	1.0	11.0	114	223	1.3	10.9	130	168	1.6	11.1	159	172	2.1	11.4	169	175	2.4	11.6	169	199	2.3	11.8	133	185	1.9	11.5	137	233	1.9	11.0	128	200	1.6	11.1	116	147	1.4	11.3	92	159	1.0	11.1	81	172	0.9	10.5	126	186	1.6	10.9
Blanco	87	189	0.9	11.0	111	235	1.3	10.8	127	158	1.6	10.9	160	145	2.1	11.0	170	182	2.4	11.1	170	194	2.4	11.4	134	172	2.0	10.9	139	197	1.9	10.6	128	195	1.6	10.9	115	145	1.4	11.2	89	143	1.0	11.1	76	179	0.8	10.3	125	178	1.6	11.5
Borden	87	124	1.0	9.7	103	195	1.2	10.1	112	166	1.4	12.4	131	131	1.7	12.1	154	121	2.1	12.8	154	129	2.1	12.3	124	193	1.7	12.8	129	161	1.7	12.5	117	118	1.5	12.5	87	139	1.0	11.0	76	151	0.8	10.3	70	173	0.8	9.7	114	150	1.4	11.1
Bosque	86	189	0.9	10.8	111	226	1.3	10.8	125	161	1.6	11.1	156	148	2.1	11.2	163	167	2.3	11.6	163	194	2.3	11.7	135	195	2.0	11.7	136	200	1.9	10.9	126	178	1.6	11.1	110	145	1.3	11.2	89	140	1.0	11.1	77	178	0.8	10.3	123	177	1.6	12.0
Bowie	84	200	0.9	10.7	108	198	1.2	11.1	119	168	1.5	12.1	153	160	2.0	12.1	163	142	2.3	13.0	163	202	2.3	12.5	143	218	2.1	13.5	138	209	1.9	12.7	132	139	1.7	12.2	109	138	1.3	11.6	87	117	1.0	11.2	76	201	0.8	10.8	122	174	1.6	10.9
Brazoria	104	258	1.1	10.7	128	204	1.4	10.8	142	196	1.8	10.1	180	196	2.3	11.2	187	231	2.6	11.3	187	298	2.4	11.2	159	272	2.3	11.0	153	244	2.0	10.7	136	252	1.7	10.9	119	153	1.4	11.1	101	213	1.1	11.1	92	210	1.0	11.0	139	227	1.8	11.2
Brazos	93	211	1.0	10.9	119	217	1.3	10.9	132	181	1.7	11.0	167	172	2.2	11.4	175	183	2.5	11.7	175	231	2.4	11.6	147	219	2.1	11.7	145	225	2.0	11.3	134	206	1.7	11.3	118	152	1.4	11.3	94	157	1.0	11.2	83	197	0.9	10.8	131	196	1.7	11.9
Brewster	81	163	0.9	11.2	104	181	1.2	11.2	110	133	1.4	11.9	138	99	1.9	12.3	126	100	1.8	12.3	126	104	1.9	12.9	110	134	1.6	12.3	121	213	1.7	12.4	100	109	1.3	12.2	102	172	1.2	11.5	94	83	1.0	11.3	80	101	0.9	11.3	108	133	1.4	10.7
Briscoe	83	151	0.9	10.1	98	162	1.1	10.2	112	231	1.4	10.5	135	159	1.8	10.7	135	225	1.9	10.9	135	253	2.0	11.1	126	203	1.8	10.7	128	156	1.7	10.9	102	155	1.3	11.0	107	142	1.2	10.8	80	145	0.9	10.7	74	151	0.8	10.5	110	178	1.4	11.3
Brooks	107	240	1.2	11.1	134	184	1.5	10.9	150	242	1.8	11.2	170	249	2.2	11.5	179	173	2.4	11.8	179	208	2.3	11.6	143	206	2.0	11.4	148	283	2.0	11.6	138	224	1.7	11.1	131	152	1.5	11.2	107	193	1.2	11.0	97	196	1.1	11.1	139	213	1.7	11.0
Brown	79	170	0.9	11.0	105	224	1.2	10.9	122	163	1.5	11.0	148	128	2.0	11.0	144	153	2.1	11.4	144	163	2.2	11.5	119	188	1.8	11.4	125	199	1.7	10.1	114	155	1.5	10.5	106	147	1.3	11.3	87	143	1.0	11.3	75	167	0.8	10.0	115	167	1.5	11.1
Burleson	92	206	1.0	10.9	117	225	1.3	10.9	132	176	1.6	10.9	166	165	2.2	11.2	176	187	2.5	11.5	176	224	2.4	11.5	145	206	2.1	11.4	145	218	2.0	11.1	133	209	1.7	11.1	118	150	1.4	11.2	93	153	1.0	11.1	81	194	0.9	10.7	130	193	1.7	10.9
Burnet	86	189	0.9	10.9	111	238	1.3	10.8	126	157	1.6	10.8	160	140	2.1	10.9	170	182	2.4	11.1	170	194	2.4	11.3	134	173	2.0	10.9	140	191	1.9	10.5	128	193	1.6	10.8	114	142	1.4	11.1	88	139	1.0	11.1	75	181	0.8	10.3	124	177	1.6	10.9
Caldwell	89	195	1.0	11.0	113	243	1.3	10.7	129	162	1.6	10.8	166	144	2.2	10.9	179	195	2.5	11.0	179	208	2.4	11.2	141	175	2.1	10.7	145	195	1.9	10.8	132	212	1.7	11.0	118	143	1.4	11.1	89	138	1.0	11.1	76	193	0.8	10.6	129	184	1.7	11.3
Calhoun	102	207	1.1	11.1	125	214	1.5	11.0	141	209	1.8	11.0	172	216	2.3	11.5	177	189	2.5	11.7	177	233	2.4	11.6	142	213	2.0	11.5	144	292	2.0	11.3	133	235	1.7	11.2	125	150	1.5	11.3	99	174	1.1	11.3	91	183	1.0	11.1	135	210	1.7	11.2
Callahan	80	179	0.9	11.2	105	232	1.3	10.9	125	187	1.6	11.0	154	106	2.1	10.8	142	166	2.1	11.4	142	171	2.2	11.4	124	228	1.8	11.4	123	214	1.7	10.8	114	183	1.5	11.2	108	147	1.3	11.3	89	144	1.0	11.6	77	217	0.8	11.2	116	181	1.5	12.0
Cameron	123	140	1.4	11.2	150	129	1.8	11.6	167	255	2.0	11.7	192	281	2.5	12.5	185	220	2.6	13.6	185	238	2.6	12.5	183	227	2.4	12.4	158	297	2.1	12.6	161	209	2.0	11.7	151	283	1.7	11.3	123	235	1.4	11.4	123	191	1.3	11.0	159	225	2.0	12.3
Camp	80	207	0.9	10.9	103	186	1.2	11.4	112	164	1.4	12.6	149	150	2.0	12.5	158	128	2.3	13.5	158	187	2.2	12.8	139	219	2.1	14.2	133	207	1.9	13.4	131	110	1.7	12.7	107	122	1.3	11.8	83	114	0.9	11.4	72	217	0.8	11.0	118	168	1.6	10.6
Carson	83	152	0.9	10.1	96	153	1.1	10.1	111	245	1.4	10.3	133	166	1.8	10.6	133	244	1.9	10.7	133	274	2.0	10.9	127	205	1.8	10.4	128	154	1.7	10.8	100	161	1.3	10.8	109	140	1.2	10.8	78	147	0.8	10.7	74	147	0.7	10.6	109	182	1.4	12.2
Cass	83	203	0.9	10.8	107	193	1.2	11.3	116	168	1.5	12.4	152	158	2.0	12.3	161	134	2.3	13.3	161	196	2.3	12.7	142	220	2.1	13.9	136	212	1.9	13.1	132	129	1.7	12.5	109	133	1.3	11.7	85	116	1.0	11.3	75	211	0.8	10.9	121	173	1.6	10.6
Castro	83	149	0.9	10.1	95	150	1.1	10.1	110	247	1.3	10.4	132	164	1.8	10.6	131	240	1.9	10.7	131	271	2.0	11.0	126	205	1.8	10.5	127	153	1.7	10.9	98	157	1.3	10.9	109	140	1.2	10.8	78	148	0.8	10.7	73	148	0.7	10.6	108	181	1.4	11.0
Chambers	105	255	1.1	10.7	130	206	1.4	10.8	143	199	1.8	10.2	181	199	2.4	11.2	188	229	2.6	11.4	188	305	2.4	11.3	162	281	2.3	11.2	156	246	2.1	10.8	137	257	1.7	11.0	120	162	1.4	11.1	101	210	1.1	11.1	93	215	1.0	11.0	141	230	1.8	12.4
Cherokee	80	209	0.9	11.0	104	185	1.2	11.5	112	166	1.4	12.6	149	151	2.0	12.5	158	127	2.3	13.6	158	187	2.2	12.9	139	221	2.1	14.2	133	211	1.9	13.5	131	111	1.7	12.7	107	122	1.3	11.8	82	117	0.9	11.4	72	223	0.8	11.1	118	169	1.6	10.9
Childress	83	160	0.9	10.3	103	193	1.2	10.4	118	184	1.5	11.0	143	143	1.9	11.0	146	183	2.1	11.4	146	206	2.1	11.5	129	197	1.9	11.4	130	169	1.8	11.1	113	152	1.4	11.1	104	147	1.2	11.0	86	133	0.9	10.8	76	156	0.8	10.4	115	169	1.5	10.8
Clay	83	187	0.9	10.3	109	217	1.2	10.3	124	159	1.6	10.8	153	138	2.0	10.8	160	167	2.2	11.2	160	200	2.3	11.2	137	201	2.0	11.4	136	169	1.9	10.7	125	151	1.6	10.8	103	137	1.2	11.0	93	120	1.0	10.8	79	149	0.8	10.3	122	166	1.6	11.2
Cochran	83	131	0.9	10.3	101	171	1.2	10.5	113	172	1.4	11.4	135	133	1.8	11.5	138	146	1.9	11.8	138	167	2.0	11.8	122	186	1.7	11.7	126	162	1.7	11.6	106	128	1.4	11.6	99	149	1.2	11.1	84	143	0.9	10.8	75	159	0.8	10.5	111	154	1.4	11.2
Coke	82	154	0.9	10.6	104	214	1.2	10.7	118	162	1.5	11.5	141	125	1.9	11.5	144	138	2.0	11.9	144	147	2.1	11.9	119	188	1.7	12.0	124	192	1.7	11.0	113	142	1.4	11.3	99	149	1.2	11.2	84	143	0.9	11.0	74	164	0.8	10.0	113	160	1.5	10.9
Coleman	78	164	0.9	11.0	104	225	1.2	10.9	121	163	1.5	11.0	147	122	2.0	11.0	139	149	2.0	11.4	139	154	2.2	11.4	116	187	1.7	11.4	122	199	1.7	10.0	112	151	1.4	10.5	106	149	1.3	11.4	87	142	1.0	11.4	74	168	0.8	10.0	113	164	1.5	11.3
Collin	85	192	0.9	10.5	110	210	1.2	10.7	123	164	1.6	11.3	155	153	2.0	11.4	164	158	2.3	12.0	164	206	2.3	11.8	142	209	2.1	12.3	139	188	1.9	11.5	130	153	1.7	11.3	107	140	1.3	11.2	91	122	1.0	10.9	78	173	0.8	10.5	124	172	1.6	10.9
Collingsworth	84	158	0.9	10.2	103	187	1.2	10.3	118	188	1.5	10.9	142	151	1.9	10.9	146	193	2.1	11.3	146	217	2.1	11.4	130	197	1.9	11.3	131	164	1.8	11.0	112	153	1.4	11.0	105	147	1.2	10.9	86	134	0.9	10.7	76	153	0.8	10.4	115	170	1.5	11.2
Colorado	97	215	1.1	10.9	121	219	1.4	10.9	136	186	1.7	10.9	169	183	2.2	11.3	178	194	2.5	11.6	178	238	2.4	11.6	146	218	2.1	11.4	146	240	2.0	11.1	133	223	1.7	11.2	120	153	1.4	11.2	95	168	1.1	11.1	85	194	0.9	10.8	133	203	1.7	11.0
Comal	89	195	1.0	11.0	113	234	1.3	10.8	128	163	1.6	10.9	162	153	2.1	11.1	172	184	2.4	11.2	172	200	2.4	11.5	136	177	2.0	11.0	140	207	1.9	10.8	129	202	1.7	11.0	116	145	1.4	11.2	90	147	1.0	11.1	77	181	0.8	10.5	126	182	1.6	11.0
Comanche	81	178	0.9	10.9	107	224	1.2	10.8	123	166	1.5	11.0	151	132	2.0	11.0	150	160	2.1	11.4	150	175	2.2	11.5	124	194	1.8	11.4	128	199	1.8	10.5	118	164	1.5	10.8	107	144	1.3	11.3	88	143	1.0	11.3	76	173	0.8	10.3	117	171	1.5	10.5
Concho	72	139	0.8	10.9	101	220	1.2	10.9	116	130	1.5	10.8	138	137	1.9	11.1	126	125	1.8	11.2	126	123	2.1	11.3	102	129	1.5	11.3	118	175	1.6	8.3	106	102	1.4	9.1	102	153	1.3	11.4	85	138	0.9	11.4	71	100	0.8	8.2	107	139	1.4	10.9
Cooke	85	193	0.9	10.2	112	217	1.2	10.3	125	160	1.6	10.9	156	148	2.1	10.9	166	164	2.3	11.4	166	211	2.4	11.3	143	206	2.1	11.6	141	169	1.9	10.9	131	153	1.7	10.8	105	136	1.2	11.0	94	116	1.0	10.7	80	151	0.8	10.3	125	169	1.6	11.0
Coryell	86	188	0.9	10.9	111	232	1.3	10.8	126	160	1.6	11.0	158	143	2.1	11.1	166	171	2.3	11.3	166	193	2.3	11.5	134	186	2.0	11.3	138	199	1.9	10.7	127	184	1.6	11.0	112	144	1.3	11.2	89	139	1.0	11.1	76	179	0.8	10.4	124	177	1.6	11.0
Cottle	83	160	0.9	10.4	103	198	1.2	10.5	118	183	1.5	11.1	143	134	1.9	11.1	145	174	2.0	11.5	145	193	2.1	11.6	127	198	1.8	11.5	128	174	1.8	11.1	112	153	1.4	11.2	103	146	1.2	11.1	86	133	0.9	10.9	75	161	0.8	10.4	115	167	1.5	11.7
Crane	83	108	0.9	10.9	104	187	1.2	11.1	113	146	1.4	11.9	135	126	1.8	12.0	136	91	1.9	12.3	136	95	2.0	12.3	115	180	1.6	12.2	123	159	1.7	12.1	105	92	1.4	12.1	99	139	1.2	11.4	90	143	1.0	11.2	78	168	0.8	10.9	111	136	1.4	11.5
Crockett	82	150	0.9	10.7	105	190	1.2	11.0	117	146	1.5	11.6	138	129	1.9	11.9	143	121	2.0	12.2	143	137	2.1	12.5	113	175	1.6	12.2	123	220	1.7	11.6	108	139	1.4	11.6	103	170	1.2	11.5	89	135	1.0	11.2	77	127	0.8	10.4	113	153	1.4	11.1

County	Jan				Feb				Mar				Apr				May				Jun				Jul				Aug				Sep				Oct				Nov				Dec				Annual			
	α	β	γ	τ	α	β	γ	τ	α	β	γ	τ	α	β	γ	τ	α	β	γ	τ	α	β	γ	τ	α	β	γ	τ	α	β	γ	τ	α	β	γ	τ	α	β	γ	τ	α	β	γ	τ	α	β	γ	τ	α	β	γ	τ
Crosby	84	143	0.9	10.2	102	185	1.2	10.4	114	187	1.4	11.4	137	138	1.8	11.4	143	167	2.0	11.8	143	184	2.1	11.7	124	195	1.8	11.7	127	166	1.7	11.5	110	141	1.4	11.5	100	146	1.2	11.0	82	142	0.9	10.7	74	161	0.8	10.3	113	163	1.4	11.8
Culberson	81	144	0.9	11.2	102	156	1.2	11.3	111	107	1.4	12.0	134	75	1.8	12.1	125	97	1.7	12.3	125	134	1.9	12.4	115	136	1.6	12.4	121	185	1.7	12.2	98	131	1.3	12.2	99	167	1.2	11.3	94	89	1.0	11.3	80	124	0.9	11.2	108	129	1.4	10.8
Dallam	83	145	0.9	10.1	99	159	1.1	10.3	113	206	1.4	10.7	136	157	1.8	10.9	136	204	1.9	11.1	136	232	2.0	11.3	127	197	1.8	11.0	129	158	1.8	11.1	104	150	1.3	11.1	105	153	1.2	10.9	83	148	0.9	10.7	75	154	0.8	10.5	111	172	1.4	11.3
Dallas	85	189	0.9	10.6	110	211	1.2	10.8	123	166	1.6	11.4	155	152	2.1	11.4	164	159	2.3	12.0	164	204	2.3	11.8	140	209	2.1	12.3	138	194	1.9	11.5	129	159	1.7	11.4	108	142	1.3	11.3	90	127	1.0	11.0	78	179	0.8	10.5	123	174	1.6	11.5
Dawson	86	105	0.9	9.8	103	190	1.2	10.2	112	163	1.4	12.3	131	135	1.7	12.1	151	105	2.0	12.7	151	110	2.0	12.3	123	195	1.7	12.7	128	144	1.7	12.4	115	99	1.4	12.4	89	134	1.1	11.0	78	160	0.9	10.4	71	182	0.8	9.8	113	144	1.4	10.6
Deaf Smith	83	148	0.9	10.1	96	150	1.1	10.2	110	242	1.3	10.4	132	163	1.8	10.6	131	236	1.9	10.7	131	267	2.0	11.0	126	204	1.8	10.5	127	154	1.7	10.9	99	156	1.3	10.9	108	142	1.2	10.8	78	149	0.8	10.7	74	149	0.7	10.6	108	180	1.4	11.7
Delta	84	197	0.9	10.6	108	201	1.2	11.0	119	165	1.5	11.8	153	154	2.0	11.8	163	146	2.3	12.6	163	201	2.3	12.2	142	214	2.1	13.1	138	196	1.9	12.3	131	138	1.7	11.9	107	135	1.3	11.4	88	118	1.0	11.1	76	190	0.8	10.7	122	171	1.6	11.1
Denton	85	188	0.9	10.4	111	215	1.2	10.6	124	164	1.6	11.1	155	150	2.1	11.2	164	163	2.3	11.7	164	206	2.3	11.5	140	207	2.1	11.9	139	183	1.9	11.2	129	159	1.7	11.1	107	141	1.3	11.1	92	124	1.0	10.9	79	165	0.8	10.4	124	172	1.6	11.2
DeWitt	97	205	1.1	11.1	120	223	1.4	10.9	136	192	1.7	11.0	168	194	2.2	11.4	176	186	2.5	11.6	176	220	2.4	11.6	139	199	2.0	11.4	142	265	1.9	11.1	132	224	1.7	11.2	122	145	1.5	11.2	96	162	1.1	11.2	86	182	0.9	10.9	132	200	1.7	11.1
Dickens	83	152	0.9	10.4	103	196	1.2	10.5	116	182	1.4	11.3	140	132	1.9	11.3	144	166	2.0	11.7	144	182	2.1	11.7	125	198	1.8	11.7	127	175	1.7	11.3	111	148	1.4	11.4	101	147	1.2	11.1	84	139	0.9	10.9	74	166	0.8	10.4	114	165	1.5	11.9
Dimmit	95	288	1.0	11.0	115	219	1.3	10.9	133	146	1.6	11.9	151	210	2.0	12.3	174	163	2.3	12.5	174	206	2.3	13.5	135	191	1.9	13.0	133	269	1.8	12.3	133	203	1.7	12.1	117	140	1.4	11.3	96	184	1.1	10.9	87	169	0.9	10.7	129	199	1.6	10.7
Donley	84	153	0.9	10.2	99	170	1.1	10.2	114	217	1.4	10.6	137	157	1.8	10.8	139	216	2.0	11.0	139	243	2.1	11.2	128	201	1.8	10.9	129	160	1.8	10.9	105	155	1.4	11.0	107	144	1.2	10.9	82	142	0.9	10.7	75	151	0.8	10.5	112	176	1.4	11.5
Duval	103	260	1.1	11.2	124	219	1.4	11.0	141	195	1.8	11.5	165	239	2.2	11.8	178	178	2.5	12.0	178	215	2.3	12.3	139	196	2.0	12.0	141	302	1.9	11.8	136	223	1.7	11.6	125	129	1.5	11.2	100	183	1.1	11.1	93	182	1.0	11.1	135	210	1.7	11.1
Eastland	81	174	0.9	10.9	106	225	1.2	10.8	123	175	1.5	11.0	152	121	2.0	11.0	146	163	2.1	11.4	146	173	2.2	11.4	124	208	1.8	11.4	126	203	1.8	10.7	116	171	1.5	10.9	107	147	1.3	11.3	88	142	1.0	11.3	76	188	0.8	10.6	117	174	1.5	11.7
Ector	84	85	0.9	10.6	103	192	1.2	10.9	112	157	1.4	12.1	134	138	1.8	12.0	140	81	1.9	12.4	140	78	2.0	12.3	118	197	1.7	12.4	124	128	1.7	12.2	107	78	1.4	12.2	96	123	1.2	11.3	87	169	1.0	11.0	76	195	0.8	10.6	111	135	1.4	11.4
Edwards	81	163	0.9	10.6	108	184	1.2	11.0	123	149	1.5	11.4	138	136	1.8	11.8	152	136	2.1	12.2	152	191	2.3	12.8	116	198	1.6	12.5	122	223	1.6	10.9	112	197	1.4	11.0	106	201	1.3	11.6	89	171	1.0	11.2	77	120	0.8	9.7	117	172	1.5	11.7
El Paso	73	149	0.8	9.4	92	99	1.0	9.9	102	124	1.3	12.8	126	77	1.7	12.4	117	128	1.5	13.2	117	158	1.6	12.6	119	119	1.6	13.3	123	262	1.6	13.1	92	264	1.2	13.0	91	158	1.1	10.9	88	159	1.0	10.0	78	102	0.8	9.4	103	150	1.3	11.4
Ellis	86	195	0.9	10.7	111	215	1.3	10.9	124	164	1.6	11.5	156	155	2.1	11.5	165	158	2.3	12.1	165	202	2.3	11.9	140	207	2.1	12.3	138	203	1.9	11.6	130	165	1.7	11.5	110	142	1.3	11.3	90	132	1.0	11.1	78	185	0.8	10.5	124	177	1.6	11.0
Erath	83	178	0.9	10.8	107	222	1.2	10.7	123	165	1.5	11.0	152	135	2.0	11.1	154	165	2.2	11.5	154	182	2.3	11.5	128	196	1.9	11.5	131	197	1.8	10.7	120	167	1.5	10.9	107	145	1.3	11.2	89	140	1.0	11.2	76	172	0.8	10.3	119	172	1.5	11.2
Falls	88	200	1.0	10.9	113	225	1.3	10.8	128	169	1.6	11.1	161	156	2.1	11.2	171	175	2.4	11.5	171	210	2.4	11.6	140	199	2.1	11.5	141	208	1.9	11.1	131	193	1.7	11.2	114	145	1.4	11.2	90	143	1.0	11.1	78	190	0.8	10.6	127	184	1.6	11.3
Fannin	85	195	0.9	10.4	110	208	1.2	10.7	123	162	1.6	11.4	155	154	2.0	11.4	165	155	2.3	12.1	165	208	2.3	11.8	143	210	2.1	12.4	140	185	1.9	11.7	132	147	1.7	11.4	107	137	1.3	11.2	91	117	1.0	10.9	78	172	0.8	10.5	124	171	1.6	11.1
Fayette	93	203	1.0	11.0	117	230	1.3	10.8	132	175	1.6	10.9	166	165	2.2	11.2	177	191	2.5	11.4	177	220	2.4	11.5	143	196	2.1	11.2	145	220	1.9	11.0	132	214	1.7	11.1	119	149	1.4	11.2	92	152	1.0	11.1	81	192	0.9	10.7	130	192	1.7	11.3
Fisher	82	167	0.9	10.7	105	221	1.2	10.7	121	178	1.5	11.4	146	116	2.0	11.2	145	157	2.1	11.8	145	164	2.2	11.7	123	212	1.8	11.8	125	199	1.7	11.2	114	165	1.5	11.5	103	148	1.2	11.2	86	142	0.9	11.2	75	195	0.8	10.7	115	172	1.5	10.9
Floyd	84	147	0.9	10.2	100	173	1.1	10.3	114	210	1.4	10.9	136	150	1.8	11.0	139	199	2.0	11.3	139	222	2.0	11.4	125	199	1.8	11.1	128	160	1.7	11.1	106	148	1.4	11.2	104	145	1.2	10.9	81	144	0.9	10.8	74	156	0.8	10.4	111	171	1.4	11.0
Foard	83	167	0.9	10.5	105	208	1.2	10.5	120	175	1.5	11.1	146	131	2.0	11.1	148	169	2.1	11.5	148	188	2.2	11.5	128	201	1.9	11.6	129	180	1.8	11.0	115	157	1.5	11.1	104	146	1.2	11.1	88	132	1.0	11.0	76	166	0.8	10.5	116	168	1.5	11.0
Fort Bend	102	250	1.1	10.8	127	207	1.4	10.8	141	194	1.8	10.3	178	194	2.3	11.2	185	223	2.6	11.4	185	287	2.4	11.3	156	263	2.2	11.1	152	243	2.0	10.8	135	245	1.7	10.9	119	154	1.4	11.1	100	204	1.1	11.1	91	208	1.0	10.9	138	223	1.8	12.1
Franklin	81	204	0.9	10.8	105	191	1.2	11.2	115	165	1.5	12.3	150	152	2.0	12.3	160	135	2.3	13.2	160	193	2.2	12.6	140	217	2.1	13.8	135	205	1.9	13.0	131	122	1.7	12.4	107	128	1.3	11.7	84	116	1.0	11.3	74	208	0.8	10.9	120	170	1.6	11.7
Freestone	87	206	0.9	10.8	111	207	1.3	11.1	123	171	1.6	11.7	157	162	2.1	11.8	166	156	2.4	12.5	166	208	2.3	12.2	142	215	2.1	12.8	139	215	1.9	12.1	131	165	1.7	11.8	111	141	1.3	11.5	88	134	1.0	11.2	78	200	0.8	10.8	124	182	1.6	11.5
Frio	94	239	1.0	11.0	116	215	1.3	10.9	133	163	1.7	11.5	155	195	2.0	11.8	170	167	2.3	12.1	170	203	2.3	12.6	133	192	1.9	12.2	135	260	1.8	11.6	129	204	1.6	11.5	117	148	1.4	11.3	95	175	1.1	11.1	85	167	0.9	10.6	128	194	1.6	11.5
Gaines	84	109	0.9	10.4	103	184	1.2	10.6	112	154	1.4	11.9	134	128	1.8	11.9	142	103	1.9	12.3	142	113	2.0	12.2	120	186	1.7	12.3	126	149	1.7	12.1	109	102	1.4	12.1	95	139	1.1	11.1	84	150	0.9	10.8	74	174	0.8	10.4	111	141	1.4	10.9
Galveston	105	266	1.1	10.7	130	203	1.4	10.7	143	197	1.8	10.0	182	197	2.4	11.1	189	239	2.6	11.2	189	311	2.4	11.2	161	283	2.3	11.0	155	242	2.1	10.6	136	259	1.7	10.8	119	154	1.4	11.1	101	221	1.1	11.0	93	215	1.0	11.0	140	232	1.8	11.3
Garza	85	137	0.9	10.1	103	193	1.2	10.3	114	174	1.4	11.8	135	130	1.8	11.7	148	144	2.0	12.2	148	156	2.1	12.0	124	192	1.8	12.3	127	169	1.7	11.9	113	135	1.4	12.0	95	144	1.1	11.0	81	143	0.9	10.6	73	165	0.8	10.0	113	157	1.4	10.9
Gillespie	82	174	0.9	10.9	108	221	1.3	10.9	123	149	1.5	11.0	150	149	2.0	11.2	152	155	2.2	11.4	152	168	2.2	11.6	121	163	1.8	11.4	130	201	1.8	9.9	118	162	1.5	10.3	110	153	1.3	11.3	88	149	1.0	11.2	75	144	0.8	9.5	118	166	1.5	11.6
Glasscock	88	105	1.0	9.6	103	197	1.2	10.1	111	160	1.4	12.6	129	138	1.7	12.3	156	98	2.1	13.0	156	99	2.0	12.5	124	194	1.7	13.1	129	148	1.7	12.8	118	97	1.5	12.8	85	132	1.0	10.9	75	163	0.8	10.1	70	182	0.7	9.6	114	143	1.4	11.3
Goliad	101	203	1.1	11.2	123	223	1.4	11.0	139	208	1.8	11.1	170	216	2.2	11.4	176	186	2.5	11.6	176	225	2.4	11.5	136	202	2.0	11.4	141	304	1.9	11.2	131	238	1.7	11.2	124	136	1.5	11.3	98	167	1.1	11.4	89	176	1.0	11.2	133	207	1.7	11.1
Gonzales	93	201	1.0	11.0	117	231	1.3	10.8	132	176	1.7	11.0	166	170	2.2	11.2	176	189	2.5	11.3	176	214	2.4	11.5	140	189	2.0	11.1	143	230	1.9	11.0	132	216	1.7	11.1	119	146	1.4	11.2	92	151	1.0	11.1	81	186	0.9	10.7	130	192	1.7	10.7
Gray	84	154	0.9	10.1	99	170	1.1	10.2	114	215	1.4	10.6	137	159	1.8	10.8	140	218	2.0	11.0	140	245	2.1	11.2	129	200	1.9	10.9	130	159	1.8	10.9	106	156	1.4	10.9	107	145	1.2	10.9	82	141	0.9	10.7	75	150	0.8	10.5	112	176	1.4	11.0
Grayson	85	194	0.9	10.2	111	214	1.2	10.4	125	160	1.6	11.1	156	151	2.1	11.1	167	161	2.3	11.6	167	211	2.4	11.5	144	208	2.1	11.9	141	174	1.9	11.2	132	151	1.7	11.0	106	137	1.2	11.0	93	115	1.0	10.8	80	157	0.8	10.3	125	169	1.6	12.6
Gregg	77	211	0.8	11.0	100	178	1.1	11.6	107	161	1.4	12.9	146	144	2.0	12.7	155	118	2.2	13.9	155	177	2.2	13.1	137	219	2.0	14.7	130	206	1.9	13.8	130	90	1.7	13.0	105	112	1.3	11.9	79	111	0.9	11.5	69	228	0.8	11.2	115	163	1.5	11.3
Grimes	96	219	1.0	10.9	121	212	1.4	10.9	134	186	1.7	10.9	169	180	2.2	11.4	177	188	2.5	11.8	177	244	2.4	11.7	150	233	2.2	11.7	147	232	2.0	11.3	135	212	1.7	11.3	118	155	1.4	11.3	95	166	1.1	11.2	86	201	0.9	10.8	133	202	1.7	11.0
Guadalupe	90	199	1.0	11.0	114	234	1.3	10.8	130	168	1.6	10.9	164	159	2.1	11.1	175	188	2.5	11.2	175	207	2.4	11.4	138	181	2.0	11.0	142	215	1.9	10.9	130	210	1.7	11.1	118	145	1.4	11.1	91	147	1.0	11.1	78	185	0.8	10.6	128	186	1.6	10.8
Hale	83	144	0.9	10.1	98	162	1.1	10.3	112	219	1.4	10.8	134	153	1.8	11.0	135	207	1.9	11.2	135	233	2.0	11.3	125	199	1.8	11.0	127	158	1.7	11.1	103	149	1.3	11.2	105	144	1.2	10.9	80	146	0.9	10.7	74	152	0.8	10.5	110	172	1.4	10.9
Hall	83	153	0.9	10.2	101	180	1.2	10.3	115	202	1.4	10.8	139	150	1.8	10.9	142	198	2.0	11.2	142	222	2.1	11.3	127	200	1.8	11.1	129	164	1.8	11.0	108	152	1.4	11.1	105	146	1.2	10.9	83	140	0.9	10.8	75	156	0.8	10.4	113	172	1.4	11.0
Hamilton	83	185	0.9	10.8	108	226	1.2	10.8	124	159	1.5	11.0	154	140	2.0	11.1	158	165	2.2	11.4	158	183	2.3	11.5	129	187	1.9	11.4	133	199	1.8	10.6	122	171	1.6	10.8	109	143	1.3	11.2	88	142	1.0	11.2	76	171	0.8	10.2	120	173	1.6	10.7
Hansford	84	151	0.9	10.1	100	168	1.1	10.2	115	208	1.4	10.7	137	160	1.8	10.8	140	214	2.0	11.0	140	241	2.0	11.2	129	197	1.9	10.9	130	160	1.8	11.0	106	158	1.4	11.0	106	149	1.2	10.8	83	142	0.9	10.7	75	149	0.8	10.4	112	175	1.4	11.0
Hardeman	83	168	0.9	10.4	105	205	1.2	10.5	120	173	1.5	11.0	146	136	1.9	11.0	150	174	2.1	11.5	150	195	2.2	11.5	130	198	1.9	11.5	131	174	1.8	11.0	116	155	1.5	11.1	104	146	1.2	11.0	88	128	1.0	10.9	77	157	0.8	10.4	117	167	1.5	11.6
Hardin	104	192	1.1	10.8	132	217	1.5	11.1	143	211	1.8	11.3	176	210	2.3	11.8	184	171	2.6	12.4	184	269	2.5	12.0	167	266	2.4	12.5	159	266	2.2	12.0	144	245	1.8	11.7	126	202	1.5	11.4	100	152	1.1	11.2	94	215	1.0	11.0	142	218	1.8	10.9
Harris	104	262	1.1	10.7	128	204	1.4	10.8	142	194	1.8	10.1	180	193	2.3	11.1	187	234	2.6	11.3	187	302	2.4	11.2	159	275	2.3	11.0	154	240	2.0	10.6	135	251	1.7	10.9	118	151	1.4	11.1	101	215	1.1	11.1	92	212	1.0	11.0	139	228	1.8	12.4
Harrison	81	206	0.9	10.9	104	186	1.2	11.4	113	167	1.4	12.6	150	153	2.0	12.5	159	126	2.3	13.6	159	188	2.2	12.9	140	221	2.1	14.3	134	212	1.9	13.4	132	113	1.7	12.7	108	126	1.3	11.8	83	114	0.9	11.4	73	221	0.8	11.1	119	170	1.6	10.7
Hartley	83	146	0.9	10.1	97	155	1.1	10.2	112	222	1.4	10.6	134	160	1.8	10.8	134	218	1.9	10.9	134	247	2.0	11.2	126	200	1.8	10.8	128	156	1.8	11.0	101	153	1.3	11.0	106	148	1.2	10.8	81	148	0.9	10.7	74	152	0.8	10.5	110	176	1.4	11.2
Haskell	81	175	0.9	10.9	105	225	1.2	10.8	123	182	1.5	11.1	151	114	2.0	10.9	144	165	2.1	11.5	144	174	2.2	11.5	125	219	1.8	11.5	125	204	1.7	11.0	115	174	1.5	11.2	106	147	1.3	11.3	88	141	1.0	11.3	77	202	0.8	11.0	116	177	1.5	10.9
Hays	88	192	0.9	11.0	112	245	1.3	10.7	128	158	1.6	10.8	165	138	2.1	10.8	178	195	2.5	10.9	178	204	2.4	11.2	140	171	2.1	10.6	144	187	1.9	10.7	131	209	1.7	11.0	117	141	1.4	11.1	88	136	1.0	11.0	74	192	0.8	10.6	128	181	1.6	10.8
Hemphill	85	159	0.9	10.1	103	188	1.2	10.3	119	181	1.5	10.9	143	158	1.9	11.0	149	198	2.1	11.3	149	222	2.2	11.4	133	193	1.9	11.4	133	162	1.8	11.0	113	156	1.4	11.0	105	151	1.2	10.9	88	129	0.9	10.6	77	146	0.8	10.3	117	170	1.5	12.1

County	Jan				Feb				Mar				Apr				May				Jun				Jul				Aug				Sep				Oct				Nov				Dec				Annual			
	α	β	γ	τ	α	β	γ	τ	α	β	γ	τ	α	β	γ	τ	α	β	γ	τ	α	β	γ	τ	α	β	γ	τ	α	β	γ	τ	α	β	γ	τ	α	β	γ	τ	α	β	γ	τ	α	β	γ	τ	α	β	γ	τ
Henderson	82	206	0.9	10.9	106	195	1.2	11.3	116	166	1.5	12.3	152	154	2.0	12.2	161	138	2.3	13.1	161	193	2.3	12.6	140	217	2.1	13.6	135	209	1.9	12.9	131	130	1.7	12.3	108	129	1.3	11.7	85	122	1.0	11.3	74	210	0.8	10.9	120	172	1.6	10.9
Hidalgo	108	255	1.2	11.0	141	154	1.6	10.8	157	287	1.9	10.8	169	257	2.2	10.9	179	156	2.4	11.3	179	190	2.3	11.0	141	209	1.9	10.6	153	251	2.0	11.2	137	222	1.7	10.6	135	151	1.6	11.0	111	201	1.2	10.8	98	215	1.1	11.0	141	212	1.7	11.3
Hill	87	193	0.9	10.7	111	222	1.3	10.8	125	164	1.6	11.3	157	153	2.1	11.4	166	165	2.3	11.8	166	201	2.3	11.8	138	202	2.0	12.0	138	203	1.9	11.3	129	177	1.6	11.3	111	145	1.3	11.3	90	137	1.0	11.1	78	183	0.8	10.5	124	179	1.6	11.2
Hockley	83	132	0.9	10.2	101	173	1.2	10.4	113	182	1.4	11.4	135	137	1.8	11.4	139	155	1.9	11.7	139	175	2.0	11.7	123	191	1.7	11.7	127	160	1.7	11.6	107	130	1.4	11.6	99	146	1.2	11.0	82	145	0.9	10.8	74	160	0.8	10.4	111	157	1.4	11.0
Hood	84	180	0.9	10.7	109	220	1.2	10.7	124	166	1.6	11.0	153	141	2.0	11.1	158	166	2.2	11.5	158	192	2.3	11.5	132	199	1.9	11.6	134	193	1.8	10.8	122	169	1.6	11.0	108	145	1.3	11.2	89	137	1.0	11.1	77	172	0.8	10.3	121	173	1.6	12.0
Hopkins	82	200	0.9	10.7	106	195	1.2	11.1	116	165	1.5	12.1	151	152	2.0	12.1	161	140	2.3	13.0	161	196	2.3	12.4	141	216	2.1	13.5	136	201	1.9	12.7	131	128	1.7	12.2	107	131	1.3	11.6	86	117	1.0	11.2	75	202	0.8	10.8	121	170	1.6	11.9
Houston	88	209	1.0	10.9	113	200	1.3	11.2	124	178	1.6	11.9	159	169	2.1	12.0	168	153	2.4	12.7	168	215	2.3	12.3	146	227	2.1	13.1	141	224	2.0	12.4	134	163	1.7	12.0	114	144	1.4	11.6	89	136	1.0	11.3	80	211	0.9	11.0	126	186	1.6	11.6
Howard	89	115	1.0	9.3	103	197	1.2	9.9	110	162	1.4	12.8	128	134	1.7	12.4	159	107	2.1	13.2	159	111	2.0	12.5	126	194	1.7	13.3	130	153	1.7	13.0	120	106	1.5	13.0	82	134	1.0	10.9	73	158	0.8	10.0	68	179	0.7	9.4	114	146	1.4	11.7
Hudspeth	78	147	0.9	10.3	98	136	1.1	10.6	107	122	1.3	12.3	132	85	1.8	12.3	123	111	1.7	12.7	123	140	1.8	12.6	118	134	1.7	12.8	122	210	1.7	12.6	97	182	1.2	12.5	95	165	1.2	11.1	90	128	1.0	10.6	78	120	0.8	10.4	106	140	1.3	11.6
Hunt	84	195	0.9	10.6	109	203	1.2	10.9	120	165	1.5	11.7	153	153	2.0	11.7	163	150	2.3	12.5	163	202	2.3	12.1	142	213	2.1	12.9	138	196	1.9	12.1	131	143	1.7	11.7	108	136	1.3	11.4	88	120	1.0	11.1	77	188	0.8	10.6	123	172	1.6	10.6
Hutchinson	84	151	0.9	10.1	98	160	1.1	10.2	113	228	1.4	10.5	135	162	1.8	10.7	136	229	1.9	10.9	136	258	2.0	11.1	128	201	1.8	10.7	129	157	1.8	10.9	103	159	1.3	10.9	108	144	1.2	10.8	81	145	0.9	10.7	74	148	0.8	10.5	111	179	1.4	11.3
Irion	82	142	0.9	10.5	104	201	1.2	10.7	116	149	1.4	11.7	137	131	1.8	11.8	144	123	2.0	12.1	144	133	2.1	12.1	116	174	1.7	12.2	124	190	1.7	11.2	111	128	1.4	11.4	98	155	1.2	11.3	84	144	0.9	11.0	74	141	0.8	9.8	112	151	1.4	11.0
Jack	83	182	0.9	10.5	108	218	1.2	10.6	123	166	1.5	10.9	152	137	2.0	11.0	156	167	2.2	11.4	156	192	2.3	11.4	132	202	1.9	11.5	133	185	1.8	10.8	122	161	1.6	10.9	105	141	1.3	11.1	91	131	1.0	11.0	78	164	0.8	10.4	120	171	1.6	11.2
Jackson	100	212	1.1	11.0	123	215	1.4	10.9	138	197	1.7	11.0	170	200	2.2	11.4	178	192	2.5	11.7	178	236	2.4	11.6	145	217	2.1	11.5	145	267	2.0	11.2	134	229	1.7	11.2	122	153	1.5	11.2	97	173	1.1	11.2	88	189	1.0	10.9	134	207	1.7	12.0
Jasper	104	153	1.1	10.9	135	225	1.5	11.3	144	220	1.8	12.0	174	220	2.3	12.2	182	136	2.6	13.0	182	250	2.5	12.5	172	260	2.5	13.4	162	279	2.2	12.8	148	240	1.9	12.3	131	230	1.5	11.6	100	114	1.1	11.3	95	218	1.0	11.0	144	212	1.9	11.9
Jeff Davis	81	149	0.9	11.4	103	163	1.2	11.4	110	111	1.4	12.1	135	72	1.9	12.2	124	91	1.7	12.3	124	123	1.8	12.8	114	130	1.6	12.5	120	175	1.7	12.3	98	118	1.3	12.2	99	169	1.2	11.4	94	79	1.0	11.3	79	117	0.9	11.3	107	125	1.4	11.7
Jefferson	107	178	1.2	10.9	137	222	1.5	11.1	147	220	1.9	11.4	179	221	2.3	11.9	186	164	2.6	12.5	186	274	2.5	12.1	172	272	2.5	12.7	163	278	2.2	12.1	147	260	1.9	11.8	130	221	1.5	11.5	102	144	1.1	11.3	97	218	1.1	11.0	146	223	1.9	11.5
Jim Hogg	105	279	1.1	11.1	128	201	1.5	10.9	145	208	1.8	11.5	165	248	2.1	11.8	180	171	2.4	12.1	180	206	2.3	12.4	143	197	2.0	12.0	144	280	1.9	12.0	140	213	1.8	11.5	128	138	1.5	11.1	104	193	1.1	10.9	95	194	1.0	11.0	138	211	1.7	11.3
Jim Wells	105	210	1.2	11.2	125	221	1.5	11.0	142	222	1.8	11.2	172	238	2.3	11.5	177	184	2.5	11.6	177	225	2.3	11.5	134	201	1.9	11.4	141	332	1.9	11.3	131	246	1.7	11.2	126	127	1.5	11.3	100	173	1.1	11.4	92	174	1.0	11.4	134	213	1.7	11.2
Johnson	86	186	0.9	10.7	111	220	1.3	10.7	125	166	1.6	11.2	156	149	2.1	11.3	163	164	2.3	11.7	163	199	2.3	11.7	137	203	2.0	11.9	137	197	1.9	11.1	127	172	1.6	11.1	109	146	1.3	11.2	90	135	1.0	11.0	78	177	0.8	10.4	123	176	1.6	11.2
Jones	81	180	0.9	11.2	105	233	1.3	10.9	125	191	1.6	11.1	154	104	2.1	10.8	142	168	2.1	11.4	142	172	2.2	11.4	124	233	1.8	11.4	123	215	1.7	11.0	114	187	1.5	11.3	108	147	1.3	11.3	89	144	1.0	11.5	77	224	0.8	11.4	116	183	1.5	11.3
Karnes	98	209	1.1	11.1	120	223	1.4	10.9	136	194	1.7	11.1	167	202	2.2	11.4	175	183	2.5	11.6	175	218	2.4	11.7	136	196	2.0	11.4	141	279	1.9	11.2	131	226	1.7	11.2	122	141	1.5	11.3	96	164	1.1	11.3	87	177	0.9	11.0	131	201	1.7	11.7
Kaufman	85	199	0.9	10.7	109	206	1.2	11.0	121	165	1.5	11.8	154	155	2.0	11.8	164	149	2.3	12.5	164	200	2.3	12.2	141	213	2.1	12.9	138	203	1.9	12.1	131	149	1.7	11.8	109	137	1.3	11.4	88	125	1.0	11.1	77	193	0.8	10.7	123	174	1.6	11.0
Kendall	87	190	0.9	10.9	111	224	1.3	10.9	127	159	1.6	11.0	156	157	2.1	11.3	164	170	2.3	11.4	164	188	2.3	11.7	129	176	1.9	11.4	135	213	1.8	10.6	125	186	1.6	10.8	114	151	1.4	11.3	90	152	1.0	11.2	78	165	0.8	10.1	123	178	1.6	11.4
Kenedy	109	209	1.2	11.2	135	179	1.6	11.1	152	246	1.9	11.2	175	251	2.3	11.6	179	184	2.5	12.0	179	218	2.4	11.6	148	210	2.0	11.5	149	295	2.0	11.6	140	228	1.8	11.2	134	173	1.6	11.2	108	196	1.2	11.2	101	191	1.1	11.1	142	215	1.8	11.3
Kent	84	153	0.9	10.4	104	205	1.2	10.5	117	175	1.5	11.6	140	126	1.9	11.5	146	154	2.0	12.0	146	165	2.1	11.9	124	199	1.8	12.0	127	181	1.7	11.5	113	149	1.4	11.6	99	147	1.2	11.1	83	141	0.9	10.8	74	173	0.8	10.3	114	164	1.5	10.9
Kerr	81	170	0.9	10.9	108	213	1.3	10.9	123	146	1.5	11.0	146	151	1.9	11.4	148	145	2.1	11.6	148	164	2.2	11.8	117	163	1.7	11.6	126	207	1.7	9.8	115	157	1.5	10.2	109	161	1.3	11.4	89	153	1.0	11.3	76	130	0.8	9.3	116	163	1.5	10.5
Kimble	73	141	0.8	10.9	102	216	1.2	11.0	116	126	1.5	10.8	138	142	1.9	11.2	128	124	1.8	11.3	128	126	2.1	11.4	102	126	1.5	11.3	118	179	1.6	8.3	106	107	1.4	9.0	103	158	1.3	11.5	86	142	0.9	11.4	71	92	0.8	8.0	107	140	1.4	11.1
King	82	161	0.9	10.6	104	207	1.2	10.6	119	179	1.5	11.2	144	126	1.9	11.2	145	164	2.1	11.6	145	179	2.2	11.6	125	203	1.8	11.7	127	184	1.7	11.2	113	156	1.5	11.3	103	147	1.2	11.1	86	136	0.9	11.0	75	174	0.8	10.5	115	168	1.5	11.8
Kinney	84	171	0.9	10.3	111	160	1.3	10.9	128	160	1.6	11.6	137	131	1.8	12.2	166	144	2.2	12.7	166	240	2.4	13.8	122	245	1.7	13.4	122	247	1.6	12.1	114	260	1.4	11.9	108	238	1.3	11.8	91	199	1.0	11.1	79	127	0.9	10.3	122	193	1.5	11.3
Kleberg	106	201	1.2	11.2	127	216	1.5	11.0	144	229	1.8	11.1	174	240	2.3	11.5	177	186	2.5	11.6	177	226	2.4	11.4	135	203	2.0	11.3	142	333	1.9	11.3	132	248	1.7	11.1	128	133	1.5	11.3	101	175	1.1	11.4	93	175	1.0	11.4	135	214	1.7	11.1
Knox	82	170	0.9	10.7	105	215	1.2	10.7	121	176	1.5	11.1	148	124	2.0	11.0	147	166	2.1	11.5	147	180	2.2	11.6	126	207	1.9	11.6	127	191	1.8	11.0	115	163	1.5	11.2	105	146	1.3	11.2	88	136	1.0	11.1	76	180	0.8	10.6	116	171	1.5	11.8
La Salle	98	295	1.1	11.1	118	227	1.3	10.9	135	155	1.7	11.8	156	225	2.1	12.2	177	171	2.4	12.3	177	207	2.3	13.2	138	188	1.9	12.7	137	278	1.8	12.2	136	204	1.7	11.9	120	126	1.4	11.2	97	183	1.1	10.9	89	178	1.0	10.8	132	203	1.6	11.6
Lamar	84	195	0.9	10.5	109	203	1.2	10.8	121	163	1.5	11.7	154	155	2.0	11.7	164	150	2.3	12.4	164	204	2.3	12.1	143	213	2.1	12.9	139	192	1.9	12.1	132	142	1.7	11.7	107	137	1.3	11.4	89	116	1.0	11.0	77	183	0.8	10.6	123	171	1.6	10.9
Lamb	83	141	0.9	10.2	98	162	1.1	10.3	112	211	1.4	10.9	134	150	1.8	11.0	135	196	1.9	11.2	135	222	2.0	11.4	124	197	1.8	11.1	127	158	1.7	11.2	103	145	1.3	11.2	104	146	1.2	10.9	81	146	0.9	10.7	74	153	0.8	10.5	110	169	1.4	10.9
Lampasas	84	186	0.9	10.9	109	230	1.3	10.8	125	158	1.6	10.9	156	141	2.1	11.0	162	169	2.3	11.2	162	184	2.3	11.4	129	178	1.9	11.1	135	196	1.8	10.4	124	177	1.6	10.7	111	143	1.3	11.2	88	142	1.0	11.1	75	171	0.8	10.2	122	173	1.6	11.2
Lavaca	96	207	1.0	11.0	120	223	1.4	10.9	135	185	1.7	11.0	168	182	2.2	11.3	177	190	2.5	11.5	177	224	2.4	11.6	143	203	2.1	11.3	144	245	1.9	11.1	133	221	1.7	11.2	120	150	1.4	11.2	94	161	1.0	11.2	84	188	0.9	10.8	132	198	1.7	11.0
Lee	90	200	1.0	11.0	115	235	1.3	10.8	130	169	1.6	10.9	166	154	2.2	11.1	177	191	2.5	11.2	177	216	2.4	11.4	142	190	2.1	11.0	144	205	1.9	10.9	132	210	1.7	11.1	118	146	1.4	11.1	90	145	1.0	11.1	78	193	0.8	10.7	129	188	1.7	11.6
Leon	89	208	1.0	10.9	114	208	1.3	11.0	126	176	1.6	11.5	161	167	2.1	11.7	169	163	2.4	12.3	169	218	2.3	12.0	144	221	2.1	12.5	142	222	1.9	11.9	133	178	1.7	11.7	114	146	1.4	11.4	90	142	1.0	11.2	80	202	0.9	10.8	127	188	1.6	11.1
Liberty	103	239	1.1	10.8	129	208	1.4	10.9	142	199	1.8	10.5	178	198	2.3	11.4	186	212	2.6	11.6	186	289	2.4	11.5	161	271	2.3	11.5	155	247	2.1	11.1	138	247	1.7	11.2	120	167	1.4	11.2	100	194	1.1	11.1	92	213	1.0	11.0	140	224	1.8	11.4
Limestone	88	202	1.0	10.8	113	218	1.3	10.9	126	169	1.6	11.4	159	161	2.1	11.5	169	167	2.4	12.0	169	211	2.3	11.9	141	208	2.1	12.1	140	212	1.9	11.5	131	182	1.7	11.5	112	145	1.3	11.3	90	139	1.0	11.1	79	192	0.8	10.6	126	184	1.6	10.9
Lipscomb	86	159	0.9	10.1	104	191	1.2	10.3	120	174	1.5	10.9	144	160	1.9	11.0	151	197	2.1	11.4	151	220	2.2	11.5	135	190	2.0	11.5	134	162	1.8	11.1	115	158	1.5	11.0	105	154	1.2	10.9	89	127	0.9	10.6	77	145	0.8	10.2	118	170	1.5	11.3
Live Oak	102	214	1.1	11.2	122	224	1.4	11.0	139	208	1.8	11.2	169	225	2.2	11.5	176	183	2.5	11.7	176	222	2.3	11.7	134	199	1.9	11.5	140	315	1.9	11.3	130	238	1.7	11.2	124	130	1.5	11.3	98	170	1.1	11.4	90	173	1.0	11.2	132	208	1.7	10.9
Llano	82	177	0.9	10.9	108	227	1.2	10.8	123	151	1.5	10.9	152	144	2.0	11.1	156	161	2.2	11.3	156	173	2.3	11.5	124	166	1.8	11.2	132	196	1.8	10.0	120	166	1.5	10.4	110	148	1.3	11.3	88	144	1.0	11.2	75	155	0.8	9.7	119	167	1.5	11.9
Loving	83	136	1.0	11.6	104	159	1.2	11.7	112	92	1.4	12.0	134	65	1.9	12.0	126	92	1.8	12.1	126	137	1.9	12.1	114	135	1.6	12.1	119	182	1.7	12.0	96	118	1.3	12.0	101	164	1.2	11.4	96	71	1.1	11.7	81	127	0.9	11.6	108	123	1.4	11.1
Lubbock	84	136	0.9	10.2	101	176	1.2	10.4	113	188	1.4	11.4	135	139	1.8	11.4	141	163	2.0	11.7	141	183	2.0	11.7	123	194	1.8	11.7	127	161	1.7	11.5	108	134	1.4	11.6	99	145	1.2	11.0	82	146	0.9	10.7	74	160	0.8	10.3	112	161	1.4	11.4
Lynn	85	125	0.9	10.0	102	185	1.2	10.3	113	171	1.4	11.9	134	133	1.8	11.8	146	131	2.0	12.2	146	144	2.0	12.0	123	192	1.7	12.2	128	158	1.7	12.0	112	119	1.4	12.0	94	142	1.1	11.0	80	150	0.9	10.6	72	169	0.8	10.1	112	152	1.4	11.5
Madison	93	212	1.0	10.9	118	210	1.3	11.0	131	182	1.6	11.3	165	174	2.2	11.6	173	173	2.4	12.1	173	230	2.4	11.9	148	227	2.1	12.2	145	228	2.0	11.7	134	194	1.7	11.5	117	152	1.4	11.4	93	153	1.0	11.2	83	202	0.9	10.8	130	195	1.7	12.3
Marion	82	205	0.9	10.9	105	189	1.2	11.4	114	167	1.5	12.5	150	155	2.0	12.5	160	129	2.3	13.5	160	191	2.2	12.8	141	221	2.1	14.1	135	213	1.9	13.3	132	120	1.7	12.6	108	129	1.3	11.8	84	115	0.9	11.4	74	217	0.8	11.0	120	171	1.6	11.6
Martin	88	84	1.0	9.6	103	196	1.2	10.1	111	165	1.4	12.6	130	144	1.7	12.3	155	85	2.0	13.0	155	80	2.0	12.5	124	203	1.7	13.0	129	125	1.7	12.8	117	79	1.5	12.7	86	121	1.0	11.0	76	177	0.8	10.2	70	200	0.7	9.7	113	138	1.4	10.6
Mason	75	151	0.8	11.0	103	220	1.2	10.9	118	133	1.5	10.8	141	143	1.9	11.2	135	133	1.9	11.3	135	137	2.1	11.4	107	137	1.6	11.3	121	184	1.7	8.7	110	120	1.4	9.4	105	153	1.3	11.4	86	142	0.9	11.4	72	110	0.8	8.5	110	147	1.4	11.2
Matagorda	102	225	1.1	10.9	126	209	1.4	10.9	141	200	1.8	10.8	174	203	2.3	11.4	181	202	2.5	11.7	181	256	2.4	11.6	151	237	2.2	11.5	148	263	2.0	11.2	135	236	1.7	11.2	122	159	1.5	11.2	99	186	1.1	11.2	91	197	1.0	11.0	137	214	1.7	11.8
Maverick	88	212	1.0	10.6	112	183	1.3	11.0	129	155	1.6	11.7	143	160	1.9	12.2	167	149	2.2	12.6	167	220	2.3	13.6	127	220	1.8	13.1	126	253	1.7	12.1	121	231	1.5	12.0	111	199	1.3	11.6	93	188	1.0	11.0	82	142	0.9	10.5	124	193	1.5	10.5

County	Jan α	Jan β	Jan γ	Jan τ	Feb α	Feb β	Feb γ	Feb τ	Mar α	Mar β	Mar γ	Mar τ	Apr α	Apr β	Apr γ	Apr τ	May α	May β	May γ	May τ	Jun α	Jun β	Jun γ	Jun τ
McCulloch	74	145	0.8	11.0	102	221	1.2	10.9	117	132	1.5	10.8	140	138	1.9	11.1	130	130	1.9	11.2	130	130	2.1	11.3
McLennan	87	193	0.9	10.8	112	227	1.3	10.8	126	164	1.6	11.1	159	152	2.1	11.3	168	171	2.4	11.6	168	203	2.3	11.7
McMullen	100	248	1.1	11.1	120	222	1.4	10.9	137	184	1.7	11.4	163	222	2.1	11.8	176	177	2.4	12.0	176	213	2.3	12.3
Medina	90	207	1.0	10.9	113	212	1.3	10.9	129	161	1.6	11.3	153	174	2.0	11.6	164	162	2.3	11.9	164	194	2.3	12.3
Menard	69	128	0.7	11.0	99	220	1.2	11.0	113	116	1.4	10.6	135	142	1.8	11.0	119	116	1.7	11.1	119	107	2.0	11.1
Midland	86	72	1.0	9.9	103	198	1.2	10.3	112	167	1.4	12.4	131	149	1.7	12.2	150	75	2.0	12.8	150	66	2.0	12.4
Milam	89	199	1.0	10.9	114	232	1.3	10.8	129	169	1.6	10.9	164	154	2.1	11.1	175	186	2.5	11.3	175	214	2.4	11.4
Mills	81	176	0.9	10.9	107	224	1.2	10.8	122	157	1.5	10.9	150	137	2.0	11.1	151	158	2.1	11.3	151	172	2.2	11.5
Mitchell	86	144	0.9	10.0	104	207	1.2	10.3	114	165	1.4	12.2	135	127	1.8	11.9	152	132	2.1	12.6	152	140	2.1	12.2
Montague	84	190	0.9	10.2	111	218	1.2	10.3	125	160	1.6	10.8	155	144	2.0	10.8	164	166	2.3	11.3	164	207	2.4	11.2
Montgomery	100	238	1.1	10.8	125	208	1.4	10.9	138	193	1.7	10.6	175	190	2.3	11.4	182	208	2.5	11.6	182	274	2.4	11.5
Moore	83	150	0.9	10.1	96	153	1.1	10.1	111	238	1.4	10.4	133	164	1.8	10.6	133	236	1.9	10.8	133	266	2.0	11.0
Morris	81	206	0.9	10.8	105	190	1.2	11.3	114	165	1.5	12.5	150	153	2.0	12.4	160	132	2.3	13.4	160	192	2.2	12.7
Motley	83	152	0.9	10.3	102	186	1.2	10.4	116	194	1.4	11.0	139	142	1.9	11.1	142	184	2.0	11.4	142	204	2.1	11.5
Nacogdoches	85	202	0.9	10.9	110	193	1.3	11.4	119	175	1.5	12.4	155	165	2.1	12.4	163	134	2.3	13.4	163	201	2.3	12.7
Navarro	86	199	0.9	10.8	111	212	1.3	11.0	123	166	1.6	11.6	156	157	2.1	11.7	166	156	2.3	12.3	166	203	2.3	12.1
Newton	107	130	1.2	10.9	139	232	1.6	11.4	148	230	1.9	12.3	176	232	2.3	12.4	184	121	2.6	13.3	184	251	2.6	12.6
Nolan	82	165	0.9	10.7	105	221	1.2	10.7	120	175	1.5	11.4	146	116	2.0	11.2	144	152	2.0	11.8	144	159	2.2	11.7
Nueces	106	190	1.2	11.3	125	229	1.5	11.0	142	230	1.8	11.0	175	238	2.3	11.4	177	189	2.6	11.5	177	231	2.4	11.2
Ochiltree	85	154	0.9	10.1	102	179	1.2	10.3	117	193	1.4	10.8	140	159	1.9	10.9	145	205	2.0	11.2	145	230	2.1	11.3
Oldham	83	148	0.9	10.1	96	151	1.1	10.2	111	238	1.4	10.4	133	163	1.8	10.7	132	233	1.9	10.8	132	264	2.0	11.0
Orange	110	124	1.2	10.9	144	236	1.6	11.4	152	239	2.0	12.2	180	241	2.3	12.3	187	121	2.6	13.2	187	263	2.6	12.6
Palo Pinto	83	178	0.9	10.7	107	220	1.2	10.7	123	169	1.5	11.0	152	133	2.0	11.0	153	166	2.2	11.5	153	185	2.3	11.5
Panola	82	204	0.9	10.9	107	188	1.2	11.4	115	170	1.5	12.6	152	158	2.0	12.5	160	128	2.3	13.5	160	192	2.2	12.8
Parker	84	181	0.9	10.6	109	218	1.2	10.6	124	166	1.6	11.0	153	142	2.0	11.1	158	166	2.2	11.5	158	195	2.3	11.5
Parmer	83	144	0.9	10.2	97	156	1.1	10.3	111	219	1.4	10.7	133	155	1.8	10.9	133	209	1.9	11.0	133	238	2.0	11.2
Pecos	82	149	0.9	11.3	104	183	1.2	11.4	112	127	1.4	11.8	138	108	1.9	12.0	130	107	1.8	12.1	130	108	2.0	12.3
Polk	97	208	1.1	10.9	124	208	1.4	11.1	135	195	1.7	11.4	169	191	2.2	11.8	177	171	2.5	12.4	177	249	2.4	12.0
Potter	83	152	0.8	10.0	94	146	1.1	10.1	109	262	1.3	10.1	131	169	1.7	10.4	130	258	1.9	10.5	130	291	1.9	10.8
Presidio	78	162	0.9	11.2	102	169	1.2	11.0	104	135	1.3	12.3	135	64	1.9	12.7	116	70	1.6	12.7	116	91	1.7	14.0
Rains	82	201	0.9	10.8	106	196	1.2	11.2	117	165	1.5	12.1	151	152	2.0	12.1	161	139	2.3	13.0	161	195	2.3	12.5
Randall	83	153	0.8	10.0	94	142	1.1	10.0	109	271	1.3	10.0	130	172	1.7	10.4	128	267	1.8	10.4	128	301	1.9	10.7
Reagan	84	123	0.9	10.3	104	195	1.2	10.6	114	153	1.4	12.0	134	133	1.8	12.0	147	107	2.0	12.5	147	112	2.1	12.4
Real	82	172	0.9	10.8	108	198	1.3	10.9	124	148	1.5	11.3	143	147	1.9	11.7	151	141	2.1	12.0	151	177	2.2	12.4
Red River	84	196	0.9	10.6	108	199	1.2	11.0	119	165	1.5	12.0	153	156	2.0	11.9	163	144	2.3	12.8	163	201	2.3	12.3
Reeves	83	140	1.0	11.8	104	155	1.2	11.8	112	82	1.4	12.0	134	54	1.9	12.0	124	90	1.8	12.1	124	140	1.9	12.1
Refugio	104	198	1.2	11.2	124	223	1.5	11.0	141	219	1.8	11.1	173	227	2.3	11.4	177	187	2.5	11.6	177	229	2.4	11.4
Roberts	84	154	0.9	10.1	100	174	1.1	10.2	115	205	1.4	10.7	139	159	1.8	10.8	142	212	2.0	11.1	142	239	2.1	11.2
Robertson	90	205	1.0	10.9	116	219	1.3	10.9	129	176	1.6	11.1	163	165	2.1	11.4	172	177	2.4	11.7	172	220	2.4	11.7
Rockwall	85	193	0.9	10.6	110	207	1.2	10.9	122	166	1.5	11.6	154	153	2.0	11.6	163	154	2.3	12.3	163	203	2.3	12.0
Runnels	79	163	0.9	11.0	104	223	1.2	10.9	121	165	1.5	11.1	146	120	2.0	11.1	139	148	2.0	11.5	139	153	2.2	11.5
Rusk	78	210	0.9	11.0	101	180	1.2	11.5	109	163	1.4	12.9	147	146	2.0	12.7	156	120	2.3	13.8	156	180	2.2	13.0
Sabine	98	167	1.1	10.9	126	216	1.4	11.3	136	204	1.7	12.1	168	202	2.2	12.2	175	135	2.5	13.1	175	232	2.5	12.5
San Augustine	93	184	1.0	10.9	120	207	1.4	11.3	130	193	1.7	12.1	163	188	2.1	12.2	172	140	2.4	13.1	172	223	2.4	12.5
San Jacinto	99	225	1.1	10.8	125	207	1.4	11.0	137	194	1.7	10.9	172	190	2.3	11.6	180	191	2.5	12.0	180	263	2.4	11.7
San Patricio	105	188	1.2	11.3	124	232	1.5	11.0	141	230	1.8	11.0	175	237	2.3	11.4	177	189	2.6	11.4	177	232	2.4	11.1
San Saba	80	169	0.9	10.9	106	224	1.2	10.9	121	148	1.5	10.9	148	139	2.0	11.1	147	150	2.1	11.3	147	160	2.2	11.4
Schleicher	76	144	0.8	10.8	103	208	1.2	10.9	117	137	1.5	11.1	137	137	1.8	11.4	135	125	1.9	11.6	135	134	2.1	11.8
Scurry	85	148	0.9	10.1	104	207	1.2	10.4	115	169	1.4	11.9	137	126	1.8	11.8	150	141	2.1	12.3	150	150	2.1	12.1
Shackelford	81	178	0.9	11.1	106	231	1.2	10.9	125	187	1.6	11.0	154	107	2.1	10.8	143	167	2.1	11.4	143	173	2.2	11.4
Shelby	88	194	1.0	10.9	113	198	1.3	11.4	123	181	1.6	12.3	157	173	2.1	12.3	166	134	2.4	13.3	166	207	2.3	12.7
Sherman	83	149	0.9	10.1	98	161	1.1	10.2	113	215	1.4	10.6	136	159	1.8	10.8	136	216	1.9	11.0	136	244	2.0	11.2
Smith	78	211	0.9	11.0	101	180	1.2	11.5	108	162	1.4	12.8	146	145	2.0	12.7	155	120	2.2	13.8	155	179	2.2	13.0

County	Jul α	Jul β	Jul γ	Jul τ	Aug α	Aug β	Aug γ	Aug τ	Sep α	Sep β	Sep γ	Sep τ	Oct α	Oct β	Oct γ	Oct τ	Nov α	Nov β	Nov γ	Nov τ	Dec α	Dec β	Dec γ	Dec τ	Annual α	Annual β	Annual γ	Annual τ
McCulloch	105	135	1.6	11.3	120	179	1.7	8.5	108	111	1.4	9.2	104	152	1.3	11.4	86	139	0.9	11.4	71	107	0.8	8.4	108	143	1.4	11.2
McLennan	138	196	2.0	11.7	139	203	1.9	11.1	129	186	1.7	11.2	113	145	1.3	11.2	89	140	1.0	11.1	77	185	0.8	10.5	125	180	1.6	11.5
McMullen	136	194	1.9	12.0	139	290	1.9	11.7	133	217	1.7	11.5	122	132	1.5	11.2	98	177	1.1	11.1	89	177	1.0	11.0	132	204	1.7	11.3
Medina	128	187	1.8	11.9	132	239	1.8	11.1	124	195	1.6	11.1	114	157	1.4	11.3	93	167	1.0	11.1	82	157	0.9	10.3	124	184	1.6	10.2
Menard	95	103	1.4	11.1	115	164	1.6	7.3	102	79	1.3	8.2	101	154	1.3	11.5	84	136	0.9	11.5	68	72	0.7	7.2	103	128	1.4	11.6
Midland	122	208	1.7	12.8	127	113	1.7	12.5	114	68	1.4	12.5	89	114	1.1	11.1	79	186	0.9	10.5	72	210	0.8	9.9	113	135	1.4	11.0
Milam	141	192	2.1	11.2	143	205	1.9	11.0	132	204	1.7	11.1	116	147	1.4	11.2	90	144	1.0	11.1	78	192	0.8	10.6	128	186	1.6	10.9
Mills	122	179	1.8	11.3	129	196	1.8	10.2	118	159	1.5	10.5	108	145	1.3	11.3	87	143	1.0	11.2	75	160	0.8	9.9	117	167	1.5	11.5
Mitchell	123	194	1.7	12.6	128	180	1.7	12.1	116	134	1.5	12.2	91	145	1.1	11.0	79	146	0.9	10.5	71	172	0.8	9.8	114	157	1.4	10.8
Montague	141	204	2.1	11.4	139	168	1.9	10.8	129	153	1.7	10.7	104	137	1.2	10.9	94	118	1.0	10.7	80	149	0.8	10.2	124	168	1.6	11.1
Montgomery	156	257	2.2	11.5	151	240	2.0	11.1	136	233	1.7	11.1	119	157	1.4	11.2	98	189	1.1	11.1	89	208	1.0	10.9	137	216	1.7	10.6
Moore	127	203	1.8	10.5	128	155	1.7	10.9	100	158	1.3	10.9	108	143	1.2	10.8	79	147	0.9	10.7	74	148	0.8	10.6	109	180	1.4	12.2
Morris	140	219	2.1	14.0	135	208	1.9	13.2	131	119	1.7	12.5	107	127	1.3	11.7	84	115	0.9	11.3	74	213	0.8	11.0	119	170	1.6	11.0
Motley	126	198	1.8	11.4	128	167	1.8	11.2	109	150	1.4	11.2	103	147	1.2	11.0	84	139	0.9	10.8	75	159	0.8	10.4	113	168	1.4	12.2
Nacogdoches	145	227	2.2	13.9	139	223	1.9	13.2	134	137	1.7	12.5	112	141	1.3	11.7	86	120	1.0	11.4	77	220	0.8	11.1	124	178	1.6	11.6
Navarro	141	210	2.1	12.6	138	208	1.9	11.9	130	163	1.7	11.7	110	141	1.3	11.4	89	132	1.0	11.1	78	193	0.8	10.6	124	178	1.6	12.2
Newton	178	265	2.6	13.8	166	293	2.3	13.1	152	253	2.0	12.5	135	254	1.6	11.7	101	98	1.1	11.4	98	221	1.1	11.1	148	215	1.9	11.2
Nolan	122	208	1.8	11.8	125	200	1.7	11.1	114	161	1.5	11.4	102	148	1.2	11.2	85	143	0.9	11.2	75	190	0.8	10.5	115	170	1.5	11.3
Nueces	130	202	1.9	11.1	140	353	1.9	11.1	128	259	1.7	11.1	126	119	1.5	11.3	99	167	1.1	11.6	91	168	1.0	11.6	133	215	1.7	10.8
Ochiltree	131	194	1.9	11.2	131	161	1.8	11.0	110	157	1.4	11.0	106	151	1.2	10.9	86	136	0.9	10.6	76	149	0.8	10.4	115	172	1.5	10.6
Oldham	126	203	1.8	10.5	128	154	1.7	10.9	99	156	1.3	10.9	108	144	1.2	10.8	79	149	0.9	10.7	74	150	0.8	10.6	109	179	1.4	12.2
Orange	183	275	2.7	13.7	171	304	2.4	13.0	155	272	2.0	12.4	138	270	1.6	11.7	103	99	1.2	11.4	101	223	1.1	11.1	152	222	1.9	11.0
Palo Pinto	129	202	1.9	11.5	131	194	1.8	10.8	119	166	1.5	10.9	106	144	1.3	11.2	89	137	1.0	11.1	77	173	0.8	10.4	119	172	1.5	12.4
Panola	142	223	2.1	14.2	136	216	1.9	13.4	133	121	1.7	12.7	110	132	1.3	11.8	84	115	1.0	11.4	75	221	0.8	11.1	121	172	1.6	11.0
Parker	133	202	2.0	11.6	134	190	1.8	10.9	123	166	1.6	11.0	107	144	1.3	11.2	90	133	1.0	11.0	77	169	0.8	10.4	121	173	1.6	10.8
Parmer	125	198	1.8	10.9	127	157	1.7	11.1	101	149	1.3	11.1	106	147	1.2	10.9	81	147	0.9	10.7	74	152	0.8	10.5	109	173	1.4	11.8
Pecos	109	145	1.6	11.8	121	232	1.7	12.0	101	106	1.3	12.0	103	164	1.3	11.6	95	89	1.0	11.6	81	113	0.9	11.4	110	136	1.4	11.6
Polk	157	249	2.3	12.5	150	245	2.1	12.0	138	210	1.8	11.7	120	171	1.4	11.4	96	153	1.1	11.2	88	212	1.0	11.0	135	205	1.7	10.5
Potter	126	209	1.8	10.2	127	151	1.7	10.7	97	162	1.2	10.7	110	137	1.2	10.7	76	149	0.8	10.7	73	146	0.7	10.6	108	186	1.4	12.2
Presidio	115	113	1.6	13.4	119	122	1.7	13.0	97	100	1.3	12.7	94	175	1.2	11.1	92	76	1.0	10.7	76	102	0.8	11.0	104	115	1.4	12.0
Rains	140	216	2.1	13.5	136	203	1.9	12.7	131	129	1.7	12.2	108	130	1.3	11.6	86	119	1.0	11.2	75	203	0.8	10.8	121	171	1.6	10.4
Randall	126	211	1.8	10.1	127	149	1.7	10.7	95	164	1.2	10.7	111	135	1.2	10.7	75	150	0.8	10.7	73	145	0.7	10.7	107	188	1.4	11.5
Reagan	118	183	1.7	12.5	125	177	1.7	12.0	112	112	1.4	12.1	95	146	1.1	11.2	83	149	0.9	10.8	74	159	0.8	10.1	113	146	1.4	11.2
Real	117	181	1.7	12.1	124	219	1.7	10.5	114	177	1.5	10.7	108	180	1.3	11.5	90	163	1.0	11.2	77	127	0.8	9.6	117	169	1.5	11.8
Red River	143	215	2.1	13.3	138	200	1.9	12.5	131	137	1.7	12.0	108	136	1.3	11.5	88	116	1.0	11.1	76	194	0.8	10.7	122	172	1.6	11.9
Reeves	113	127	1.6	12.1	119	186	1.7	12.0	95	118	1.3	12.0	102	168	1.3	11.5	98	56	1.1	11.8	82	119	0.9	11.8	108	119	1.4	11.3
Refugio	134	204	2.0	11.3	141	325	1.9	11.2	130	247	1.7	11.1	125	131	1.5	11.3	99	169	1.1	11.5	91	173	1.0	11.3	133	211	1.7	10.8
Roberts	130	198	1.9	11.0	130	160	1.8	11.0	108	156	1.4	10.9	106	147	1.2	10.9	84	138	0.9	10.7	75	149	0.8	10.4	113	174	1.4	11.3
Robertson	143	210	2.1	11.7	143	218	1.9	11.3	132	196	1.7	11.3	115	149	1.4	11.3	91	149	1.0	11.1	80	194	0.9	10.7	128	190	1.7	11.5
Rockwall	141	212	2.1	12.6	138	196	1.9	11.9	130	151	1.7	11.6	108	139	1.3	11.3	89	123	1.0	11.1	77	184	0.8	10.6	123	173	1.6	11.0
Runnels	117	190	1.7	11.5	122	199	1.7	10.2	112	152	1.4	10.6	105	150	1.3	11.3	87	142	1.0	11.4	75	170	0.8	10.1	113	165	1.5	12.6
Rusk	138	220	2.1	14.6	131	208	1.9	13.7	131	96	1.7	12.9	106	116	1.3	11.9	80	112	0.9	11.5	70	227	0.8	11.2	116	165	1.5	12.1
Sabine	163	246	2.4	13.5	154	260	2.1	12.8	144	206	1.8	12.3	125	201	1.5	11.7	96	114	1.1	11.3	89	216	1.0	11.0	137	200	1.8	12.1
San Augustine	156	239	2.3	13.5	148	245	2.1	12.8	140	183	1.8	12.3	120	177	1.4	11.7	93	121	1.0	11.3	85	216	0.9	11.0	132	193	1.7	11.4
San Jacinto	156	254	2.3	12.0	151	242	2.0	11.5	137	222	1.7	11.4	119	163	1.4	11.3	97	173	1.1	11.2	89	210	1.0	11.0	136	211	1.7	11.2
San Patricio	129	201	1.9	11.1	140	357	1.9	11.1	127	261	1.6	11.0	126	115	1.5	11.3	98	165	1.1	11.6	91	166	1.0	11.6	133	215	1.7	10.8
San Saba	118	164	1.7	11.3	127	192	1.7	9.7	116	149	1.5	10.2	107	148	1.3	11.3	87	143	1.0	11.3	74	144	0.8	9.5	115	161	1.5	10.9
Schleicher	107	148	1.6	11.7	120	189	1.7	9.5	108	122	1.4	10.0	102	162	1.2	11.5	86	143	0.9	11.3	73	111	0.8	8.9	110	147	1.4	11.4
Scurry	124	197	1.8	12.4	127	180	1.7	11.9	115	140	1.5	12.0	94	145	1.1	11.1	81	144	0.9	10.6	72	175	0.8	10.0	114	160	1.4	11.2
Shackelford	124	228	1.8	11.4	124	212	1.7	10.9	114	183	1.5	11.2	108	147	1.3	11.3	89	143	1.0	11.5	77	216	0.8	11.2	116	181	1.5	12.2
Shelby	149	230	2.2	13.8	142	230	2.0	13.1	136	152	1.8	12.5	115	154	1.4	11.7	88	118	1.0	11.4	80	218	0.9	11.0	126	182	1.6	10.7
Sherman	127	198	1.8	10.9	129	158	1.8	11.0	103	155	1.3	11.0	106	149	1.2	10.8	82	145	0.9	10.7	75	150	0.8	10.5	111	175	1.4	12.5
Smith	137	219	2.0	14.5	131	206	1.9	13.7	130	94	1.7	12.9	105	114	1.3	11.9	80	112	0.9	11.5	70	226	0.8	11.1	116	164	1.5	11.1

County	Jan				Feb				Mar				Apr				May				Jun				Jul				Aug				Sep				Oct				Nov				Dec				Annual			
	α	β	γ	τ	α	β	γ	τ	α	β	γ	τ	α	β	γ	τ	α	β	γ	τ	α	β	γ	τ	α	β	γ	τ	α	β	γ	τ	α	β	γ	τ	α	β	γ	τ	α	β	γ	τ	α	β	γ	τ	α	β	γ	τ
Somervell	84	187	0.9	10.7	109	223	1.2	10.7	124	163	1.6	11.1	154	145	2.0	11.2	160	167	2.3	11.6	160	193	2.3	11.6	133	197	2.0	11.7	134	196	1.8	10.9	124	172	1.6	11.0	109	143	1.3	11.2	89	140	1.0	11.1	77	175	0.8	10.3	121	175	1.6	11.3
Starr	106	261	1.2	11.1	135	175	1.5	10.9	151	246	1.9	11.2	167	251	2.2	11.4	179	165	2.4	11.8	179	199	2.3	11.7	143	204	1.9	11.4	149	265	2.0	11.6	139	216	1.7	11.1	132	150	1.5	11.1	108	198	1.2	10.8	97	203	1.0	11.0	140	211	1.7	11.1
Stephens	81	175	0.9	10.9	106	224	1.2	10.8	123	176	1.5	11.0	152	120	2.0	10.9	147	165	2.1	11.4	147	177	2.2	11.4	126	211	1.9	11.5	127	201	1.8	10.8	116	171	1.5	11.0	107	147	1.3	11.3	89	140	1.0	11.3	77	190	0.8	10.7	117	175	1.5	11.5
Sterling	86	136	0.9	10.0	104	203	1.2	10.3	113	158	1.4	12.2	133	131	1.8	12.0	152	121	2.0	12.6	152	129	2.1	12.3	122	186	1.7	12.7	127	177	1.7	12.1	116	123	1.5	12.2	91	145	1.1	11.1	79	148	0.9	10.5	71	162	0.8	9.7	113	151	1.4	11.2
Stonewall	82	165	0.9	10.7	104	217	1.2	10.7	120	179	1.5	11.3	147	117	2.0	11.1	144	160	2.1	11.7	144	170	2.2	11.6	124	211	1.8	11.7	125	194	1.7	11.2	113	164	1.5	11.4	103	148	1.2	11.2	86	140	0.9	11.2	76	190	0.8	10.7	115	171	1.5	11.1
Sutton	78	151	0.9	10.8	104	199	1.2	10.9	119	141	1.5	11.2	138	136	1.8	11.6	140	128	2.0	11.8	140	151	2.1	12.1	110	164	1.6	11.9	120	202	1.6	10.0	108	145	1.4	10.4	104	174	1.3	11.5	87	150	1.0	11.3	74	113	0.8	9.2	112	155	1.4	10.5
Swisher	83	151	0.9	10.1	95	149	1.1	10.1	110	253	1.3	10.3	132	166	1.8	10.6	131	248	1.9	10.6	131	279	2.0	10.9	126	207	1.8	10.4	127	153	1.7	10.8	98	159	1.3	10.8	109	139	1.2	10.7	77	148	0.8	10.7	73	147	0.7	10.6	108	183	1.4	11.1
Tarrant	85	184	0.9	10.5	110	216	1.2	10.7	124	167	1.6	11.2	155	149	2.0	11.2	162	164	2.3	11.7	162	203	2.3	11.6	138	205	2.0	11.9	137	190	1.9	11.1	127	166	1.6	11.1	108	145	1.3	11.2	90	130	1.0	11.0	78	172	0.8	10.4	123	174	1.6	11.2
Taylor	80	179	0.9	11.2	105	234	1.3	11.0	125	190	1.6	11.1	154	104	2.1	10.8	142	167	2.1	11.4	142	170	2.2	11.4	124	232	1.8	11.4	123	216	1.7	10.9	114	186	1.5	11.3	108	147	1.3	11.3	89	145	1.0	11.6	77	223	0.8	11.3	116	183	1.5	11.8
Terrell	81	166	0.9	11.3	105	193	1.3	11.3	113	136	1.4	11.6	140	127	1.9	12.0	132	121	1.9	12.1	132	100	2.0	12.2	104	143	1.5	11.5	121	288	1.7	12.0	102	106	1.3	12.0	107	174	1.3	11.9	96	83	1.1	11.7	82	89	0.9	11.6	110	144	1.4	11.3
Terry	84	121	0.9	10.2	102	181	1.2	10.5	113	166	1.4	11.7	134	131	1.8	11.7	143	125	2.0	12.1	143	139	2.0	12.0	122	189	1.7	12.1	127	155	1.7	11.9	109	115	1.4	11.9	96	142	1.1	11.1	82	149	0.9	10.7	74	169	0.8	10.3	112	148	1.4	11.1
Throckmorton	81	175	0.9	10.9	106	223	1.2	10.8	123	178	1.5	11.1	151	117	2.0	10.9	146	165	2.1	11.5	146	177	2.2	11.5	126	215	1.9	11.5	126	199	1.8	10.9	115	172	1.5	11.1	106	147	1.3	11.2	89	138	1.0	11.3	77	193	0.8	10.8	117	175	1.5	12.1
Titus	81	205	0.9	10.8	105	191	1.2	11.3	115	165	1.5	12.4	150	153	2.0	12.3	160	135	2.3	13.2	160	193	2.2	12.6	140	218	2.1	13.8	135	206	1.9	13.0	131	122	1.7	12.4	107	128	1.3	11.7	84	115	1.0	11.3	74	209	0.8	10.9	120	170	1.6	10.9
Tom Green	78	146	0.9	10.7	103	212	1.2	10.8	117	144	1.5	11.2	139	132	1.9	11.4	137	129	1.9	11.7	137	135	2.1	11.7	111	159	1.6	11.7	122	185	1.7	10.0	110	123	1.4	10.4	101	154	1.2	11.3	85	141	0.9	11.2	73	128	0.8	9.2	111	149	1.4	10.8
Travis	87	191	0.9	11.0	112	251	1.3	10.7	127	156	1.6	10.7	166	132	2.2	10.7	180	200	2.6	10.7	180	206	2.4	11.1	142	168	2.1	10.4	146	178	2.0	10.7	133	212	1.7	11.0	118	139	1.4	11.0	87	131	0.9	11.0	73	197	0.8	10.6	128	180	1.7	11.8
Trinity	92	208	1.0	10.9	118	203	1.3	11.2	129	185	1.6	11.6	164	178	2.2	11.9	172	161	2.4	12.6	172	229	2.4	12.2	150	236	2.2	12.9	145	233	2.0	12.2	136	182	1.7	11.9	116	155	1.4	11.5	92	144	1.0	11.3	83	211	0.9	11.0	130	194	1.7	11.8
Tyler	101	182	1.1	10.9	129	216	1.5	11.2	139	207	1.8	11.7	172	205	2.2	12.0	179	155	2.5	12.7	179	249	2.5	12.2	164	254	2.4	13.0	156	261	2.1	12.4	143	224	1.8	12.0	125	198	1.5	11.5	98	135	1.1	11.3	91	215	1.0	11.0	139	208	1.8	12.5
Upshur	78	210	0.9	10.9	101	181	1.2	11.5	109	163	1.4	12.8	147	147	2.0	12.6	156	122	2.3	13.8	156	181	2.2	13.0	138	219	2.1	14.5	131	207	1.9	13.6	131	99	1.7	12.9	106	117	1.3	11.9	81	112	0.9	11.4	71	224	0.8	11.1	116	165	1.5	11.6
Upton	84	105	0.9	10.5	104	193	1.2	10.8	113	155	1.4	12.0	135	135	1.8	12.1	143	93	2.0	12.4	143	92	2.0	12.4	117	188	1.6	12.4	125	158	1.7	12.1	109	92	1.4	12.1	97	135	1.2	11.3	86	154	0.9	11.0	75	174	0.8	10.5	112	140	1.4	11.5
Uvalde	87	194	1.0	10.7	111	195	1.3	10.9	128	156	1.6	11.4	145	158	1.9	11.8	161	150	2.2	12.2	161	199	2.3	12.8	124	199	1.8	12.5	127	239	1.7	11.3	119	204	1.5	11.3	111	183	1.3	11.5	92	174	1.0	11.1	81	141	0.9	10.2	122	183	1.5	11.8
Val Verde	83	163	0.9	10.5	109	165	1.2	11.0	124	155	1.5	11.6	136	125	1.8	12.1	157	136	2.1	12.6	157	208	2.3	13.4	118	224	1.6	13.0	121	247	1.6	12.0	110	224	1.4	11.9	106	225	1.3	11.8	91	174	1.0	11.2	79	119	0.8	10.5	118	180	1.5	12.1
Van Zandt	82	205	0.9	10.8	106	195	1.2	11.2	116	164	1.5	12.2	151	153	2.0	12.2	161	137	2.3	13.1	161	192	2.3	12.6	140	216	2.1	13.6	135	206	1.9	12.9	131	127	1.7	12.3	108	128	1.3	11.6	85	120	1.0	11.3	74	208	0.8	10.9	120	171	1.6	11.3
Victoria	100	206	1.1	11.1	123	219	1.4	11.0	139	202	1.7	11.0	170	207	2.2	11.4	176	188	2.5	11.6	176	228	2.4	11.6	140	207	2.0	11.4	143	284	1.9	11.2	132	232	1.7	11.2	123	146	1.5	11.3	98	169	1.1	11.3	89	182	1.0	11.1	133	206	1.7	11.4
Walker	96	219	1.0	10.9	121	208	1.4	11.0	134	188	1.7	11.1	169	182	2.2	11.6	176	183	2.5	12.0	176	247	2.4	11.8	152	241	2.2	12.1	147	235	2.0	11.6	136	208	1.7	11.5	118	157	1.4	11.3	95	164	1.1	11.2	86	206	0.9	10.9	133	203	1.7	11.1
Waller	99	231	1.1	10.8	124	211	1.4	10.9	138	190	1.7	10.6	173	187	2.3	11.3	181	204	2.5	11.5	181	263	2.4	11.5	153	244	2.2	11.4	149	238	2.0	11.0	135	230	1.7	11.1	119	155	1.4	11.2	97	183	1.1	11.1	88	203	1.0	10.9	135	212	1.7	11.8
Ward	83	131	0.9	11.5	104	166	1.2	11.6	112	104	1.4	12.0	135	79	1.9	12.0	128	92	1.8	12.1	128	126	1.9	12.2	114	145	1.6	12.1	120	179	1.7	12.0	98	111	1.3	12.0	101	159	1.2	11.5	95	86	1.1	11.7	81	135	0.9	11.5	109	126	1.4	11.1
Washington	95	214	1.0	10.9	120	220	1.4	10.9	134	182	1.7	10.9	169	175	2.2	11.3	177	191	2.5	11.5	177	236	2.4	11.5	147	219	2.1	11.4	146	228	2.0	11.1	134	216	1.7	11.2	119	152	1.4	11.2	94	163	1.1	11.1	84	196	0.9	10.8	132	199	1.7	12.1
Webb	101	374	1.1	11.2	117	245	1.3	10.9	136	128	1.7	12.2	154	253	2.0	12.6	183	172	2.4	12.7	183	208	2.2	14.1	143	179	2.0	13.4	137	289	1.8	12.9	145	195	1.8	12.5	121	99	1.4	11.1	98	192	1.1	10.6	92	190	1.0	11.0	134	211	1.7	11.2
Wharton	100	225	1.1	10.9	124	212	1.4	10.9	139	194	1.7	10.7	172	194	2.3	11.4	180	202	2.5	11.6	180	254	2.4	11.5	150	235	2.1	11.4	148	251	2.0	11.1	134	232	1.7	11.1	120	155	1.4	11.2	98	182	1.1	11.1	89	197	1.0	10.9	135	211	1.7	10.8
Wheeler	84	159	0.9	10.1	103	187	1.2	10.3	118	186	1.5	10.8	142	155	1.9	10.9	147	197	2.1	11.3	147	222	2.1	11.4	132	195	1.9	11.3	132	162	1.8	11.0	112	154	1.4	11.0	105	148	1.2	10.9	87	132	0.9	10.7	76	149	0.8	10.3	116	171	1.5	10.9
Wichita	83	182	0.9	10.3	108	215	1.2	10.4	123	160	1.5	10.9	151	135	2.0	10.9	157	168	2.2	11.3	157	197	2.3	11.3	135	200	2.0	11.4	135	170	1.8	10.8	123	153	1.6	10.8	103	140	1.2	11.0	92	122	1.0	10.8	78	152	0.8	10.3	121	166	1.5	10.9
Wilbarger	83	175	0.9	10.4	107	212	1.2	10.5	122	167	1.5	11.0	149	134	2.0	11.0	153	171	2.2	11.4	153	194	2.2	11.4	132	201	1.9	11.5	132	176	1.8	10.9	119	157	1.5	11.0	104	144	1.2	11.0	90	127	1.0	10.9	78	159	0.8	10.4	119	168	1.5	11.5
Willacy	115	196	1.3	11.1	143	149	1.7	11.2	160	262	1.9	11.3	180	265	2.3	11.7	182	190	2.5	12.5	182	217	2.4	11.8	161	217	2.1	11.6	154	280	2.0	11.9	148	217	1.8	11.2	142	214	1.6	11.2	115	214	1.3	11.1	109	199	1.2	11.0	149	218	1.9	10.9
Williamson	87	192	0.9	11.0	112	246	1.3	10.7	128	159	1.6	10.8	165	138	2.1	10.8	178	195	2.5	10.9	178	206	2.4	11.2	141	173	2.1	10.6	145	185	1.9	10.7	132	209	1.7	11.0	117	141	1.4	11.1	88	135	1.0	11.0	74	194	0.8	10.6	128	181	1.6	11.2
Wilson	94	208	1.0	11.0	117	225	1.4	10.9	133	180	1.7	11.1	163	185	2.1	11.4	173	181	2.4	11.5	173	210	2.3	11.7	136	190	2.0	11.4	140	251	1.9	11.1	130	214	1.7	11.2	119	144	1.4	11.2	94	160	1.0	11.2	83	178	0.9	10.7	129	194	1.7	11.8
Winkler	83	121	0.9	11.3	104	173	1.2	11.4	112	121	1.4	12.0	135	97	1.8	12.0	131	92	1.8	12.2	131	116	1.9	12.2	115	160	1.6	12.2	121	167	1.7	12.1	100	105	1.3	12.0	100	150	1.2	11.4	93	110	1.0	11.5	79	151	0.9	11.3	109	130	1.4	11.0
Wise	84	185	0.9	10.4	110	217	1.2	10.5	124	164	1.6	11.0	154	145	2.0	11.0	161	165	2.3	11.5	161	202	2.3	11.4	137	204	2.0	11.6	137	182	1.9	10.9	126	161	1.6	10.9	106	142	1.3	11.1	92	127	1.0	10.9	78	163	0.8	10.3	123	171	1.6	12.3
Wood	80	208	0.9	10.9	103	186	1.2	11.4	112	163	1.4	12.6	148	149	2.0	12.5	158	127	2.3	13.5	158	185	2.2	12.8	139	218	2.1	14.2	133	206	1.9	13.4	131	109	1.7	12.7	106	121	1.3	11.8	82	115	0.9	11.4	72	218	0.8	11.0	118	167	1.5	11.4
Yoakum	83	123	0.9	10.4	102	176	1.2	10.6	113	158	1.4	11.7	135	126	1.8	11.7	139	122	1.9	12.0	139	140	2.0	12.0	121	183	1.7	12.0	126	160	1.7	11.8	107	116	1.4	11.8	97	147	1.2	11.1	85	142	0.9	10.9	75	163	0.8	10.5	111	146	1.4	11.0
Young	82	176	0.9	10.7	107	220	1.2	10.7	123	170	1.5	11.0	151	126	2.0	11.0	150	165	2.1	11.4	150	183	2.2	11.4	128	207	1.9	11.5	129	191	1.8	10.8	118	165	1.5	11.0	106	145	1.3	11.2	89	135	1.0	11.1	77	177	0.8	10.6	118	172	1.5	11.9
Zapata	103	337	1.1	11.2	122	226	1.4	10.9	140	161	1.7	11.9	158	252	2.1	12.3	182	172	2.4	12.5	182	206	2.2	13.4	144	187	2.0	12.9	141	284	1.9	12.6	143	201	1.8	12.1	124	116	1.5	11.1	101	194	1.1	10.7	94	193	1.0	11.0	136	211	1.7	11.7
Zavala	91	229	1.0	10.8	114	201	1.3	10.9	130	155	1.6	11.6	148	178	2.0	12.0	167	156	2.3	12.3	167	205	2.3	13.1	129	200	1.8	12.7	130	254	1.7	11.8	125	209	1.6	11.7	114	170	1.4	11.4	94	179	1.0	11.0	84	153	0.9	10.5	126	191	1.6	11

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